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A University Training Corps for Mysore.

THE formation of a University Training Corps in the Mysore University has been engaging the attention of the authorities and recently Professor E. G. McAlpine who has had considerable experience of military affairs in the Volunteer Corps, has drawn up a memorandum on the subject. Through his courtesy, we were permitted to peruse this document and we have also received a note on the same subject, written by Sir P. S. Sivaswamy Aiyer, who was one of the members of the Shea Committee, appointed by the Government of India to report on the Non-Regular Military Forces in India. The resolution passed at the meeting of the Senate held in November 1934 runs as follows:—

"That it be a recommendation to the University Council to arrange for instituting and conducting a University Training Corps with a view to giving the University students military training."

After an exhaustive study of the budgets of the various institutions in which University Training Corps exists, Mr. M. Ramachandra Rao in moving the resolution pointed out that it was apparently possible to maintain and conduct a University Training Corps in Mysore at a sum of money ranging from a few hundreds to about Rs. 2,500. Professor McAlpine is of the opinion that these figures bore no approximation to the actual cost of a University Training Corps, for, in presenting the Defence Budget of the Government of India, His Excellency the Commander-in-Chief informed the Council of State that Government actually spent Rs. 6 lakhs per year on University Training Corps. Apart from the cost of maintenance, the memorandum proceeded to emphasise the fact that a University Training Corps has nothing to do with a University except that its personnel of officers, non-commissioned

officers and men consists of the teaching staff and students of the institutions concerned. For the University Training Corps are part of the Defence Forces of India and the Defence Department of the Government of India maintains them at a cost of Rs. 6 lakhs per annum and the purpose for which they exist and the conditions under which they train are matters in which the Universities supplying the personnel are not consulted. Col. Loch, Chief Commandant, Mysore State Troops, in a separate note which he wrote on the University Training Corps, has pointed out that the Corps form part of Indian Territorial Force and must therefore come under the Territorial Forces Act of 1920.

The inauguration of a University Training Corps in an Indian State involves problems not merely of finance, but they also bear a political, constitutional and administrative character. Before we deal with these aspects of the subject, it is necessary to deal with the fundamental issue raised by Professor McAlpine in his memorandum. Without referring to the aims and objects of similar organisations in the United Kingdom, so far as India is concerned, they have been clearly defined in the report of the Auxiliary and Territorial Forces Committee published in 1925. We are not aware whether the Government of India have since modified them, and whether there is ground to maintain that the declared purpose of the U.T.C. is to supply suitable officers and possibly also non-commissioned officers for the Indian Territorial Force and that the military training given to students is only an incidental result of this organisation and not its essential purpose. If there is no public document issued by the Government of India subsequent to the publication of the Shea Committee report in modification of the views expressed by that body, then it is obvious that there is confusion of ideas. In paragraphs 8 and 9, the Committee have set forth in unambiguous language the rôle of the University Training Corps and its functions and liabilities :—

" In order to achieve the greatest measure of success in this form of national education, it is essential that it should commence at as early an age as possible, when the mind is most receptive. When a man is full-grown, it is no easy matter to alter his outlook, and to graft new ideals upon those he has already set up for himself. The seed must be sown before his mind is formed, and for this reason it appears to us that the schools, colleges and Universities offer the most suitable medium through which the first phase of this education can be carried out. We recognise that at the present time, there may be serious difficulties in the way of establishing cadet corps in all schools in India, but a beginning can be made even in schools with the teaching of elementary principles of civic duty and with physical training and elementary military drill. In the Universities, the great opportunity lies, and here it is possible to communicate more advanced ideas on the subjects of patriotism and self-defence to a large and increasingly influential section of the population. We are of opinion that in the present state of India's evolution, and for many years to come, the University Training Corps should be regarded as the most important section of the Territorial Force. By means of the University Training Corps, if properly organised and developed, it is possible to educate and influence over a number of years that large body of young men who should become the leaders of thought and the teachers of the next generation. Their training in the principles and the practice of military service will not be limited to themselves, for, when they go out into the world, they will, if their military training has been adequate, take with them the spirit of patriotism, the sense of discipline and the improved physique which will be their legacy from the University Training Corps, and their example should serve to inspire a widening circle of the people of India with a sense of the benefits which fitness for military service confers both upon the individual and the community as a whole. We therefore recommend that the University Training Corps be viewed as the foundation stone of the national army and that no artificial limit be set to the expansion of these Corps, every encouragement being given to the formation and development on sound lines of fresh contingents in all Universities and Colleges where they do not already exist. In conformity with the general principle, which we have previously enunciated, we are of opinion that no form of state compulsion should be adopted to secure the enlistment of students in the U.T.C.—but we should, at the same time, be content to leave it, to the authorities of each individual University to decide whether as a matter of University discipline and regulation, it should be made obligatory for their undergraduates to join the U.T.C.

Since we contemplate that the object of the U.T.C. shall be primarily educational, and because

of the youthfulness of their members we suggest that these Corps should not have any liability for military service. Our own judgment and the evidence we have received lead us to believe that the imposition of such liability would be most unpopular with parents, and would frustrate the purposes which, in our opinion, the U.T.C. should serve. Moreover, it is clear that in actual practice the military authorities would never reckon upon the U.T.C. as an effective military weapon,—and there is no advantage to be gained by prescribing an obligation which it is never intended to exact. The members of the U.T.C. should, however, be encouraged by every other means to realise that they are being trained to qualify for service in the other sections of the Indian Territorial Force, where they can have a practical opportunity of undertaking to defend their country, which is alike the duty and privilege of every citizen. We envisage the U.T.C. of the future not only as a school for training the young idea in elementary military matters, but as the recognised recruiting ground for the officers, non-commissioned officers and men of the Indian Territorial Force, and later also as a potential source of supply of candidates for commissions in the Regular Indian Army.

The success of the U.T.C. in the rôle which we recommend should be allotted to it depends not solely upon the military but also upon the University authorities. Any efforts which the former may make to promote keenness and efficiency may easily be rendered nugatory by a lack of co-operation on the part of the latter, and in like manner, when encouragement is shown by the University authorities to the members of the U.T.C., the task of their military instructors will be facilitated. We feel confident, however, that the University authorities may be relied upon to reinforce, in a practical manner, any efforts which the Government may make to stimulate the successful evolution of the U.T.C."

In their recommendations, the Committee have formulated the proximate and distant ideals of the University Training Corps. The former emphasise that the elementary principles of military training should form an integral part of any scheme of national education and the purpose ought to be to inculcate in the youthful minds a strong sense of discipline and patriotism with the power of self-defence, while the latter point to a period that when the U.T.C. has become thoroughly popular and its benefits are widely utilised, it ought to become the source for the supply of offieres, non-commissioned officers and men of the Indian Territorial Force. If this experiment is to succeed, then the Committee contemplate that the U.T.C. should serve as the foundation upon which the regular army should be built up. In any case the intention of the Committee seems that the U.T.C. should, in the first instance, form part of the extra-mural activities of the educational institutions, and that the results achieved would furnish the basis for the formulation of a scheme for integrating the U.T.C. into the Indian Territorial Force and the Regular Army. There are distinct and separate phases in the evolution and future development of the U.T.C. organisation. The declared purpose is educational and popularisation of the principles of military training among the younger generation and we do not believe that the Committee at any time thought that the immediate object of the U.T.C. was to supply officers and non-commissioned officers for the I.T.F. Further, we are not convinced that the military training of the U.T.C. is only an incidental process of recruiting officers for another branch of service. It is an educational end in itself in the initial stages. We are apt to confuse the stages and the purposes of each stage of the development of the U.T.C., and it is this tendency to mix up the objects of the successive phases of the organisation that has led to radical differences of opinion regarding the desirability and necessity of establishing U.T.C. in the educational institutions.

It is pointed out that the formation of a U.T.C. in an Indian State involves problems from which British India is exempt. If the Government have laid down the maxim in modification of the recommendations of the Shea Committee that the U.T.C. is the direct source of recruitment of officers for the I.T.F., and that therefore it forms a Unit of the general defence scheme, then it must be admitted that the resolution of the Senate of the Mysore University assumes a political complexion. But if the U.T.C. still retains its educational character, there can be no reason to suppose that the Government of India would oppose its introduction into the Indian States, the question of officering and financing the State U.T.C. being left to the Government concerned for final solution. The relation of State U.T.C. with similar organisations in British India,

and the question of their being linked up with the general army defence scheme and of the contribution of finances by the Central Government will naturally be considered in the States entering the proposed Federation. In the near future, the whole problem of the relation of the armed forces of Indian States to the general defence of India must come up for review, but even then, the primary educational purpose and the broad moral and civil outlook of the U.T.C. scheme will not be subordinated to military ideals. Whether the financial responsibility for organising and maintaining a U.T.C. should or should not belong to the Universities, will, in a large measure, depend upon the view taken of the U.T.C. itself. If it is distinctly a military body forming part of the general defence budget, then the finances must be derived from the military budget; but, if the U.T.C. is part of the national educational scheme, its cost must be defrayed partly from the University finance. If at the present moment the cost is debited to the army budget, the explanation must be found in the fact that though the U.T.C. has no real military value as an effective weapon, the ideal is that the Corps will foster the growth and diffusion of military spirit and a desire on the part of the educated people to participate in the benefits of the training either in the defence of the country or in the recuritment to the effective fighting forces. Besides such training could only be given by the Military Department. It is in this sense that the U.T.C. is part of the defence forces of India.

The generous enthusiasm which the U.T.C. evoked among the undergraduates in the earlier days was not, as is suggested, due to motives of preferment in public services, but was inspired by the genuine desire to profit by military training for which the authorities had made adequate financial provision. But the low estimate of the military value of the U.T.C. was soon reflected in the grudging spirit in which provision was made in the budget for the expansion of the U.T.C. and in the step-motherly treatment accorded to it by the authorities. It is obvious that the military authorities at the headquarters are always deeply anxious to guard against any possible retrenchment in the expenditure which they consider necessary for the maintenance of the highest efficiency and standard of the regular forces, and they should naturally become afraid that the existence of the U.T.C. and the non-regular forces like I.T.F. and Auxiliary Forces might be used as an argument for cutting down military expenditure. This apprehension resulted in the policy of a progressive reduction of finances for the maintenance of the U.T.C. with the unfortunate consequence that those who were attracted by the benefits of the training were ultimately repelled by the parsimonious allowances permitted to them. The cost of maintaining the 5th (Madras) Battalion which comprises four companies, each with a personnel of 165, amounts to about Rs. 85,000 per annum, of which more than 41,000 is spent upon the pay of Adjutant, British staff and clerical and menial establishments, while the remainder is devoted to the maintenance of the U.T.C. personnel and the annual cost of upkeep, stores, arms, equipment, clothing and other expenditure.

If the Government of Mysore proposes to establish a U.T.C. at their own expense, the Government of India are not likely to take any serious objection to it and might be willing to lend the services of selected officers for the purpose of military training. On this basis the University of Calcutta has formulated their scheme of military training as part of its educational course. The U.T.C. can never be regarded as a material addition to the armed forces of the State or as a source of potential danger to the stability of the Empire. The lines along which Calcutta has framed the scheme are wise and have earned the approbation of the Provincial and Central Governments and we fail to see any reason why the Indian States should not formulate similar schemes for the benefit of their subjects. It is the ambition of the people of India, which is both natural and legitimate, that they should share in the responsibility of governing their country and of defending it, and should not opportunities be given to them to qualify for such national duties?

The Raman Effect and Molecular Structure.*

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1. Introduction.

THE great interest evinced by scientists in molecular spectroscopy in recent years is not surprising, because with that is connected the exact determination of many physical constants defining a molecule such as the frequencies of vibrations, the nuclear distance of the constituent atoms, the valence angle, the force of attraction between the atoms or groups of atoms and its variability with environment, the moment of inertia and the symmetry of the molecule as a whole. Many of the physical and chemical properties of substances depend upon one or other of these molecular constants and hence the importance of the spectroscopic study of substances cannot be overestimated. These constants are calculated from the vibration and rotation frequencies of the molecule, based on a suitable assumption for the form and structure of the molecule. The first progress in molecular spectra was made by observations in the ultra-violet and the infra-red and much valuable information was obtained regarding the structure of simple molecules. But the experimental technique for the determination of frequencies especially by infra-red observations is difficult and laborious and the presence of a large number of overtones and combinations makes the interpretation of the observed bands especially in the complicated molecules rather uncertain. This made the progress necessarily slow.

The discovery of the Raman effect by Sir C. V. Raman in 1928, marked a new era in Molecular Spectroscopy. It furnished a simple means of obtaining from a single photograph a fund of information regarding the vibration frequencies and allied properties of any molecule. It has the advantage over the infra-red in that these frequencies are rendered easily accessible in the visible and the ultra-violet part of the spectrum where the dispersion of the spectrograph and the sensitiveness of the photographic plate are both great. Unlike the infra-red, the occurrence of the overtones and harmonics is rare and consequently, the identification of the frequencies is easy and their interpretation is more accurate. Thus it is no wonder that the number of investigations in this new field of research has far surpassed those which have been stimulated by any other scientific discovery in recent times.

2. Infra-Red Absorption.

The absorption or emission of radiation by a molecule depends upon the probability of transition of the molecule from one of its stationary states to another as contemplated by quantum theory. This transition may be either electronic in which case the absorption takes place in the *Ultra-violet* and the visible regions or it may be either rotational or vibrational in which cases the absorption takes place in the *Infra-red*. The wave-length corresponding to the absorption of the incident radiations in the infra-red gives the frequency of vibration or rotation (or their overtones and combinations) of the molecule. But only those vibrations of the molecule are active in absorption which are accompanied by changes in the *permanent electric moment* of the molecule. The vibrations of the atoms within the molecules, which are symmetrical with respect to the centre, therefore, cause no absorption in the infra-red. Thus the vibration frequency of molecules like H_2 or O_2 or the breathing frequency of a tetrahedral molecule is 'inactive' in the infra-red.

3. Raman Spectra.

The Raman spectrum owes its origin to the interaction between a light quantum and a molecule. When a transparent substance is irradiated with monochromatic light of frequency ν and the scattered light is examined by means of a spectrograph, several new frequencies are observed. The incident light quantum interacts with the molecule and raises it to a higher energy level. The molecule immediately drops either to the ground level itself giving rise to the classical, coherent '*Rayleigh Scattering*'

* In partial fulfilment of a thesis for the degree of Doctor of Science of the Madras University, submitted on 25th October, 1936.

or to one or other of the excited vibrational or rotational levels of the molecule giving rise to the 'incoherent' or 'modified' lines called 'Raman lines' or 'Raman rays'. If the molecule happens to be in an excited state during collision with the light quantum, transference of energy may take place from the molecule to the light quantum and the scattered light will consequently possess enhanced frequencies and give rise to 'anti-Stokes lines'. While the infra-red absorption involves only one process, the Raman effect is the result of a double transition involving three stationary levels. If the incident light contains more than one wave-length as is the case in practice, each of them would give rise to its own set of new lines having exactly identical frequency shifts. Thus the phenomenon is essentially different from *fluorescence* which appears in the same region of the spectrum irrespective of the wave-length of the exciting radiation. The difference in wave-numbers between the frequency of the exciting line and the new frequencies of the scattered light is of the order of the infra-red frequencies and often coincide with the latter.

The selection rules governing the appearance of a Raman line have been worked out exhaustively by Placzek[1] who has shown that the vibrations of the molecule which introduce changes in the *induced electric moment* (*i.e.*, polarisability) of the molecule are active in the Raman effect. The symmetrical oscillations of the molecule which are usually missed in the infra-red consequently, come out most prominently and the anti-symmetrical vibrations are either weak or inactive in the Raman scattering. Thus the Raman spectra and the infra-red absorption are not identical but complementary in character. The frequency shift, the intensity which depends upon the change in the polarisability of the molecule during the vibration, the state of the polarisation of the line which depends upon the symmetry character of a particular vibration and its appearance or non-appearance in the infra-red are the four features that are necessary for the identification of the mode of vibration responsible for any particular Raman line.

4. Molecular Structure.

The most important direct information that is furnished by the study of the Raman effect in a substance is the magnitude, the state of polarisation and the relative intensities of the frequencies of the different modes of vibrations executed by the atoms in a molecule. The co-relation of these natural frequencies with molecular structure can be effected only on the basis of some suitable model assumed for the molecule. Much progress has been made in this direction by the work of Dennison[2] and Bhagavantam[3] and recently by Wilson,[4] Rosenthal,[5] Nagendra Nath,[6] Manneback[7] and others. The dynamical theory of vibrations of polyatomic molecules based upon the directed bond forces between particles has yielded fruitful results.

The rules governing the polarisation characteristics of vibrations have been dealt with in detail by Placzek[1] and a useful summary of the number of vibrations allowed in the Raman effect and in the infra-red absorption and their state of polarisation for a whole series of polyatomics has been published by Wilson.[8]

For a molecule containing N atoms, there are 3N degrees of freedom. Excluding three of these which produce only rotation as a whole and three which produce only translatory motion of the molecule, there are $3N - 6$ normal vibrations for a molecule. For a linear molecule there are only two degrees of freedom of rotation and hence the number of normal vibrations is $3N - 5$. The evaluation of the normal vibrations is very much simplified if the molecule possesses some form of symmetry.

The simplest case of an oscillator is obviously the diatomic in which the two atoms are bound together with a force F. This type of molecule possesses only a single fundamental frequency given by the expression $\nu = 2\pi \sqrt{F/\mu}$, where μ is the reduced mass given by $1/\mu = 1/m_1 + 1/m_2$, m_1 and m_2 being the masses of the constituent atoms.

Tri-atomic molecules.—With the molecules of the type AX_2 there are three possibilities, (1) in which the molecule is linear and symmetrical, (2) in which the molecule is linear but unsymmetrical, and (3) in which the molecule is non-linear or bent. To the first type belongs CO_2 and CS_2. These molecules possess a centre of symmetry and give rise to a single Raman line, corresponding to the symmetrical oscillations of the extreme atoms towards or

away from the central carbon atom. This frequency is highly polarised and does not appear in the infra-red. But in both these cases another line appears in the Raman effect which is shown by Fermi[9] as due to *accidental degeneracy* caused by the overtone of the lower frequency coinciding with the fundamental. Recently, the author[10] has shown that the di-halides of Hg, Zn and Cd also belong to this type and this conclusion has been supported by the isoelectronic properties of these molecules as shown recently by Penny and Sutherland.[11] The second and the third group of molecules give rise to three lines in the Raman effect which enable the force constants and the valence angles to be calculated. A case of special interest is the N_3-ion in the azides. Recent investigations by the author† have yielded four lines for sodium azide out of which one is due to accidental degeneracy and the other three are the normal frequencies. These results seem to show that the ion is either linear and unsymmetrical or bent.

Tetra-atomic molecules.—Molecules of the type AX_3 possess six normal frequencies out of which by reason of symmetry some may be multiply coincident or *degenerate*. These degenerate frequencies are shown by Placzek[1] to be completely depolarised. Cases of special interest in this type are (1) the plane triangular and (2) the pyramidal molecules. Both these types possess four normal vibrations two of which are single and parallel and two are perpendicular and doubly degenerate. Only CO_3, NO_3 and guanidonium[12] ions are known to belong to the plane, equilateral type and one of the vibrations parallel to the symmetry axis is forbidden in the Raman effect. All the tri-halides, the chlorates, bromates and iodates and ammonia are pyramidal in structure. An experimental fact of some significance in this connection is the splitting of the parallel vibrations if the height of the pyramid is small. Placzek[13] was the first to observe this in ammonia and he explained it as due to *positional degeneracy* in these modes of oscillations. Similar splitting in iodates,[14] bromates,† and chlorates† have been observed. In iodates the symmetrical oscillation shows further splitting which has been tentatively explained as due to further accidental degeneracy. An interesting case of a tetra-atomic molecule where all the atoms are identical is the phosphorus molecule. The number of Raman lines and their states of polarisation[15] indicate a perfectly tetrahedral structure for P_4.

Penta-atomic molecules.—Molecules of the AX_4 type possess nine normal vibrations. Most of them, *e.g.*, the tetra-halides, sulphates, selenates, phosphates and chromates† are tetra-hedral and yield four Raman lines. Of these lines, one is symmetrical and single, one is doubly degenerate and two are triply degenerate. The crystalline KIO_4† however, yields a more complicated spectrum due probably to the fact that the ionic group IO_4 is distorted in the crystal lattice. A similar influence on the vibration frequencies by crystal forces has been clearly brought out recently by the work of Ananthakrishnan.[16]

In the case of complicated molecules, as is generally met with in organic chemistry, this mode of classification is almost impossible unless the molecule possesses a high degree of symmetry. But systematic researches of a large number of compounds of similar constitution and possessing the same groups by several investigators notably Kohlrausch[17] and his school have led to the identification of certain frequencies with certain definite groups and their presence or absence has been made use of in settling important problems regarding molecular structure. Thus the frequency due to the C—H group falls in the neighbourhood of 3,000 cm.$^{-1}$ and of OH at about 3,500 cm.$^{-1}$ and it is easy to see that these frequencies cannot undergo any appreciable variation due to a change in the rest of the molecule; for the mass of the hydrogen atom is very low compared with the mass of the other atoms and therefore, the reduced mass of the oscillating group is determined almost entirely by the mass of the hydrogen atom. But it has been observed that the CH frequency in the aromatic compounds is greater than in the aliphatics. Recently, the author[18] has observed that in the formate ion this frequency falls as low as 2,830 cm.$^{-1}$. Similarly, the OH frequency shifts from 3,650 cm.$^{-1}$ in KOH to about 3,400 cm.$^{-1}$ in the alcohols and very much further down in the case of inorganic acids.† These

† Unpublished work of the author.

changes in the C—H or the O—H frequencies should only be due to the variation in the valence force between the hydrogen and the carbon or the oxygen and show the influence of the surrounding electric field on the properties of molecules.

This explanation of the constancy of the CH and the OH frequencies does not hold good for other groups where the vibrating particles are of comparable mass (*e.g.*, C = O). In these cases the frequency of vibration is constant within certain limits; because when the forces holding the atoms together in the neighbouring groups are very dissimilar, the influence on the vibration of any one group due to its coupling with other groups is unimportant with the result that it vibrates without being appreciably influenced by the neighbouring atoms. This also accounts for the constancy of the double or the triple bond frequencies.

If however, there are more groups than one in a compound in which all the forces are of the same order, resonance will take place among the valence vibrations, which generally leads to the splitting of the lines. This is apparently the explanation for the multiplicity of the lines in many organic molecules.

A factor of great importance for the assignment of the Raman lines is their state of polarisation. Instances of this are furnished by the recent study of the polarisation of the Raman lines of many organic and inorganic substances in this laboratory.[19]

5. Electrolytic Dissociation.

From what has been said about the molecular structure, it will be evident that some difference could be expected in the spectra of complete molecules and their products of dissociation. In fact, one of the fruitful applications of Raman spectra is for the determination of the degree and the manner of dissociation of solutions of electrolytes due to varying concentrations. The classical theory of electrolytic dissociation due to Arrhenius was based on the postulate that on solution in water electrolytes dissociate completely into positively and negatively charged ions. On the assumption that these ions are independent of one another Ostwald[20] deduced his well-known 'dilution law,' for the variation of conductivity of electrolytes with concentration. The results of experiment showed a quantitative agreement with the demands of this conception in the case of weak electrolytes; but there was almost a complete breakdown of the law even for dilute solutions of strong electrolytes. Obviously the failure of the theory was due only to the fact that in the strong electrolytes in which the ions are relatively large in number, the distance between the ions cannot be very great and therefore, bring the interionic attraction into play. To explain satisfactorily, this anomalous behaviour of strong electrolytes Debye and Hückel[21] and later Onsager[22] postulated a new theory of electrolytes based upon the assumption of an 'ionic atmosphere' as a point charge surrounding the ion in solution. The theory successfully explained many anomalies on the dependence of concentration in the measurements of osmotic and activity coefficients and solubility influences for completely dissociated strong electrolytes. The empirical law enunciated by Kohlrausch[23] that the percentage deviation of equivalent conductivity of moderately dilute solutions of strong electrolytes from their limiting value at infinite dilutions is proportional to the square root of the concentration, was also readily explained by the Debye-Hückel theory. An extension of the theory by Debye and Falkenhagen[24] led to the remarkable prediction of the dependence of the conductivity of electrolytic solutions upon the frequency, which was subsequently confirmed by Sack.[25] In the case of concentrated solutions of strong electrolytes, however, systematic deviations were observed from the theoretical laws of Debye and his co-workers. Recent advances in arriving at a rigid theory for concentrated solutions lie in the direction of attributing a finite diameter for the ionic atmosphere instead of treating it as a point charge. Further modifications are introduced by assuming association of ions in solution[26] and incomplete dissociation[27] in concentrated solutions of strong electrolytes. Before a more rigorous and satisfactory theory could be attempted it is important to determine exactly the degree of association of the ion and the degree of dissociation of the molecules at varying concentrations of electrolytes in solution.

X-ray studies of crystals afford some evidence in this direction. It has been

found that most salts belong to 'ionic' or 'heteropolar' type in which atoms or atom groups are present in the crystal as ions. The ions are separated by spaces in which electron density is small and the electrostatic forces of attraction which keep the crystals in tact affect equally all neighbouring ions and in all directions. If the crystal contains polyatomic groups, SO_4, NO_3, etc., the complex preserves the same characteristic in all salts and behaves as a single ion. This ionic character of the building units in a crystal and the absence of any molecular complex are responsible for the fact that most salts are ionised in the solid state as well as solutions and yield sharp Raman lines.

The Raman lines owe their origin to the vibrations of atoms within the molecule or the polyatomic ion. The fact that a large number of inorganic salts of metals have yielded only lines characteristic of the acid radical both in the state of crystals and solutions, shows that the lines are due to ionic groups in both cases and lends support to the ionic conception of these salts as revealed by X-rays.

When a salt dissolves in water, the regular arrangement of ions in the crystal disappears and ions remain either as separate entities, alone or as loosely bound complexes, or form a mixture of undissociated molecules and dissociated ions. In the latter case, the vibration characteristics of the separate units are different and each of them give rise to its own lines. If the product of the concentration and the time of exposure is kept constant, the intensity of each line would be proportional to the number of scattering particles responsible for it and the relative intensities of the lines due to the complete molecule and the ionisation products would give to a first approximation the degree of dissociation at different concentrations of the electrolyte.

The method of the Raman spectra, which is the only reliable method available at present for concentrated solutions, has been successfully applied at first for nitric acid by Ramakrishna Rao[28] and later for sulphuric acid,[29] iodic acid and selenic acid.[30] Phosphoric and selenious acids[31] are comparatively weak; but they have also revealed that the dissociation is progressive and step-wise in character. The case of sulphuric acid and selenic acid is particularly interesting; for it affords a method of comparing the behaviour of electrolytes belonging to the same homologous series. Unlike these two acids, telluric acid is a weak electrolyte and has given rise to three Raman lines† which further indicate that Te $(OH)_6$ is octohedral in structure.

All the metallic salts of these acids, on the other hand, give only lines characteristic of the acid radical and are, therefore, completely dissociated even in concentrated solutions. This difference between the acids and the salts is obviously due to the fact that while the hydrogen atom in the acids is capable of forming both electrovalent and covalent linkages, the electropositive metals form only electrovalent compounds.

6. Homopolar and Heteropolar Compounds.

The above discusion leads us to the consideration of homopolar and heteropolar compounds. X-rays have revealed to us that two common types of atomic arrangements that exist in the solids are (1) the heteropolar or ionic compounds like NaCl in which the forces holding the atoms together are electrostatic and (2) the homopolar or molecular compounds like diamond or most of the organic substances in which the units of the crystals are molecules possessing covalent bonds. It was shown by Krishnamurti[32] that the covalent type of binding gives rise to Raman lines and the electrovalent type does not give any Raman spectra. This empirical relation between the Raman effect and the nature of binding has been substantiated theoretically by Placzek[33] on the basis that no resultant change in polarisability is induced in the electrovalent molecules. Even after a comparatively long exposure under satisfactory conditions of experiment with rocksalt Fermi and Rasetti[34] succeeded in obtaining the Raman spectrum of only the second order, the first order not appearing because of the equal and opposite changes of polarisability of the ions in the crystal lattice. From the point of view of covalent chemistry it is interesting to know which of the salts of metals form covalent compounds and which of them form electrovalent compounds. X-rays have shown that halides of alkalies and the

alkaline-earth metals form ionic lattices and the halides of mercury, the metalloids and the non-metals form molecular lattices. The Raman spectra have confirmed the above conclusions and have shown further that the halides of zinc and cadmium are also covalent while those of magnesium and aluminium are electrovalent. Aqueous solutions of zinc chloride[35] show a gradual diminution of intensity of the Raman line as the dilution is increased and indicate that there is a progressive change from the covalent form to the electrovalent form. As explained before, the dissociation of acids also shows that the change from the covalent to the electrovalent form is only gradual.

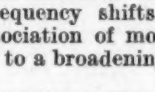
7. Change of State and Raman Effect.

Closely connected with the nature of chemical bonds is the remarkable change that accompanies the Raman lines due to a change in the state of aggregation of a substance. It has been observed that generally covalent molecules like sulphur and phosphorus or ions like NO_3 do not undergo any appreciable change in frequency when they pass from the solid to the liquid and from the liquid to the gaseous state. On the contrary, molecules like HCl and HBr which are polar and which change to the electrovalent form in solution are accompanied by large changes in frequency, the shift of the line being smaller in the solid than in the liquid and in the liquid than in the vapour. Striking changes have been observed in the Raman lines of the selenic and selenious acids due to a change from the solid to the molten condition. The act of solution in water of zinc chloride and cadmium iodide has a similar effect on the magnitude of the frequency shift. If the process of solution is taken as akin to vapourisation, the measured changes in frequency can be easily understood as due to change of state.

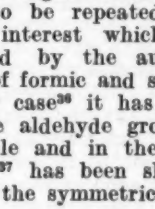
Another change that has been observed especially in iodic, selenic and selenious acids when they are melted or dissolved in water is the remarkable broadening of the Raman lines. In the case of crystals of these acids the lines are sharp. As has been shown by the author, the ionisation of molecules of these acids start even in the solid state. The only difference between the solid and the liquid or the solution is, therefore, that while in the solid the molecules or the ions are rigid bodies arranged in a regular manner and incapable of forming complexes, in the liquids and solutions the lattices break up to some extent and the ions and molecules are free to form loosely bound complexes. Besides, of course, there is also the field due to the solvent in the case of solutions. It is not unreasonable to attribute the broadening of the lines in solutions of high concentrations at least partly, to the formation of associated or polymerised molecules or complex ions as postulated by Bjerrum. As the dilution progresses the complex breaks up giving rise to relatively sharper lines. These conclusions are supported by the fact that in water, formic acid and acetic acid which are known to be associated, the Raman lines are excessively broad. Thus while dissociation is accompanied by appreciable frequency shifts of characteristic lines, association of molecules or ions gives rise only to a broadening.

8. Some Constitutional Problems.

Examples of the application of Raman spectra for solving questions concerning constitution of organic molecules are too well known to be repeated here. Some problems of interest which have been recently solved by the author are the constitutions of formic and selenious acids. In the former case[36] it has been able to show that the aldehyde group is present in the molecule and in the formate ion. Selenious acid[37] has been shown to exist in two forms, the symmetrical



and the unsymmetrical



in dynamical equilibrium with each other. The symmetrical form is predominant in aqueous solutions and the unsymmetrical form in solids and the alcoholic solutions. Other instances arising out of the recent investigations are the constitution of the 'chamber acid' by Angus and Leckie,[38] of phosphorus acid by Ananthakrishnan,[39] and of a large number of heavy compounds by American workers.

9. Rotational Raman Effect and Lattice Oscillations.

Hitherto we were concerned with only the vibration frequencies of molecules. But Raman lines also arise from transitions in the rotational energy levels. In the case of liquid and gaseous hydrogen and deutrium[40] and other gases whose moment of inertia is small, these rotational lines appear as discrete lines well separated from each other and from the Rayleigh line and their frequency shifts and intensities give valuable information regarding the moment of inertia and allied properties of the molecule. But if the moment of inertia is large as in benzene, the rotational Raman lines fall close together and very near to the Rayleigh line and appear as a *wing* accompanying the latter. Theoretically, the intensity of the wing should start from a minimum near the Rayleigh line and after reaching a maximum, should fall off rather abruptly. Experimentally several investigators[41] have observed that the intensity starts from a maximum at the unmodified line itself and falls off only gradually. This difference between the theory and the experiment has led to various speculations regarding the origin of the wing in the liquids.

Recently Gross and Vuks[42] found that this wing in the liquids breaks up into discrete bands when examined in the solid state. They have assigned these lines to vibrations characteristic of the crystal lattice and have put forward the hypothesis that the wing in the liquids is partly due to the rotation of individual molecules and partly due to lattice oscillations of crystal groups that persist in the liquid state. This observation if fully substantiated, is of enormous interest and lends strong support to the quasi-crystalline structure of fluid state.

Bhagavantam[43] is, however, of opinion that these low frequencies observed by Gross and Vuks are only due to the hindered rotation of solid molecules by virtue of their anisotropy.

Sirkar[44] has also observed low frequencies in a large number of organic crystals and in a few simple substances like H_2S, CS_2 and CCl_4; but he has suggested that these frequencies owe their origin to intermolecular oscillations of polymerised groups of molecules in the solid state. His chief objection for attributing these lines to lattice oscillations is that though these frequencies shift to a higher value due to a lowering of temperature as is to be expected, the coefficients of expansion of the crystals calculated from the observed changes of frequency with temperature are not of the proper magnitude. For the purpose of the calculations he has employed the generalised formula of Lindemann[45] which is strictly true only for monatomic cubic lattices. In a recent paper, Sirkar and Gupta[46] deduce this general expression from Braunbeck's formula[47] for the frequency of oscillation of any lattice composed of two kinds of atoms and argue that it is applicable to any crystal system. It may be pointed out that Braunbeck's formula is valid only for the *ionic* lattices like NaCl in which there is only a single mode of vibration which is supposed to take place between the layer composed of sodium atoms and the other layer composed of the chlorine atoms. But the formula ceases to be strictly valid for molecular lattices where one set of lattice units vibrates against a similar set of like molecules. In these cases there may occur more than one mode of vibration depending upon the complexity of the lattice, as is substantiated by the observed facts. Another objection raised by Sirkar and his co-worker is that some of these lines are more intense than the symmetric oscillations of the molecule itself and that this fact cannot be explained by Placzek's theory of polarisability of Raman lines. It is known that diamond yields a very intense line which has been shown by Nagendra Nath[48] to be due to a degenerate, yet symmetrical oscillation of the diamond lattice. Therefore, the intensity and the polarisation of the lines due to the lattice vibrations depend upon the symmetry and degeneracy of the oscillation; and it does not *a priori* follow that they should be less intense than any of the vibrations of the molecule. On the other hand, it is highly improbable that substances like carbon tetrachloride or carbon disulphide should form stable polymerised groups in the solid state.

The author[49] has recently obtained lines of low frequency in relatively simple molecules like sulphur and phosphorus and a fair agreement has been observed between the experimentally observed frequencies

and those calculated from the melting points, assuming the approximate validity of the Lindemann formula for molecular lattices of these substances. Phosphorus as well as carbon tetrachloride is *isotropic* and the occurrence of the depolarised low frequency in this case excludes the possibility suggested by Bhagavantam that it may be due to hindered rotation of solid molecules. There is also no chemical evidence that polymerised groups like P_4—P_4 or S_8—S_8 exist in these cases. Therefore, it may be safely concluded that the crystal lattice is responsible for these lines. Further evidence for this view has been furnished by the recent work of Vuks[50] with mixed crystals and various crystalline modifications of the same substance.

1. Placzek, G., *Leipziger Vorträge*, 1931; *Handbuch der Radiology*, 1934, **6**.
2. Dennison, D. M., *Phil. Mag.*, 1926, **1**, 195.
3. Bhagavantam, S., *Ind. Jour. Phys.*, 1930, **5**, 73.
4. Wilson, E. B., *Phys. Rev.*, 1934, **45**, 706.
5. Rosenthal, J. E., *ibid.*, 1934, **45**, 538; **46**, 730.
6. Nagendra Nath, N. S., *Ind. Jour. Phys.*, 1934, **8**, 581; *Proc. Ind. Acad. Sci.*, (A), 1934, **1**, 250.
7. Manneback, C., *Ann. Soc. Sci. de Bruxelles*, 1935, **55**, 5.
8. Wilson, E. B., *Jour. Chem. Phys.*, 1934, **2**, 432.
9. Fermi, *Zeit. f. Phys.*, 1931, **71**, 250.
10. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **1**, 850.
11. Penny and Sutherland, *Proc. Roy. Soc.*, (A), 1936, **156**, 84.
12. Jagannath Gupta, *Jour. Ind. Chem. Soc.*, 1936, **13**, 575.
13. Placzek, G., and Ammaldi, E., *Z. f. Phys.*, 1933, **81**, 259.
14. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **2**, 119.
15. Venkateswaran, C. S., *ibid.*, (A), 1935, **2**, 260; 1936, **3**, 345; Bhagavantam, S., *Ind. Jour. Phys.*, 1930, **5**, 35.
16. Ananthkrishnan, R., *Proc. Ind. Acad. Sci.*, (A), 1937, **5**, 447.
17. Kohlrausch, K. W. F., *Der Smekal-Raman Effekt*, 1931, Julius Springer, Berlin; Hibben, J. H., *Chem. Reviews*, 1936, **18**, 1.
18. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **2**, 615; *Curr. Sci.*, 1936, **4**, 736.
19. Ananthakrishnan, R., *ibid.*, 1936, **3**, 201; **4**, 74 & 82; 1937, **5**; Venkateswaran C. S., *ibid.*, (A), 1936, **4**, 174 and 345.
20. Ostwald, W., *Z. Phys. Chem.*, 1888, **2**, 36 and 270.
21. Debye, P., and Hückel E., *Phys. Z.*, 1923, **24**, 185.
22. Onsager, L., *ibid.*, 1926, **27**, 388; 1927, **28**, 277.
23. Kohlrausch, F., and Holborn, L., *Das Leitvermögen der Elektrolyte*, Leipzig, 1916.
24. Debye, P., and Falkenhagen, H., *Phys. Z.*, 1928, **29**, 121 and 401.
25. Sack, H., *ibid.*, 1928, **29**, 627.
26. Bjerrum, N., *Ergeb. d. exakt Naturwiss.*, 1926, **6**, 125.
27. Nerst, W., *Z. Electro Chem.*, 1927, **33**, 428.
28. Ramakrishna Rao, I., *Proc. Roy. Soc.*, (A), 1930, **127**, 279.
29. Nisi, H., *Jap. Jour. Phys.*, 1929, **59**, 334; Woodward, L. A., *Phys. Z.*, 1931, **32**, 690.
30. Venkateswaran, C. S., *Proc. Ind. Acad. Sci*, 1935, **2**, 119; 1936, **3**, 307.
31. Venkateswaran, C. S., *ibid.*, 1936, **3**, 25 and 533.
32. Krishnamurti, P., *Nature*, 1930, **125**, 892.
33. Placzek, G., *Leipziger Vortäge*, 1931, 92.
34. Fermi and Rasetti, *Z. f. Phys.*, 1931, **71**, 689.
35. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **1**, 850.
36. Venkateswaran, C. S., *ibid.*, 1935, **2**, 615.
37. Venkateswaran, C. S., *ibid.*, 1936, **3**, 533.
38. Angus, W. R., and Leckie, A. H., *Proc. Roy. Soc.*, (A), 1935, **149**, 327.
39. Ananthakrishnan, R., *Nature*, 1936, **138**, 803.
40. Bhagavantham, S., *Proc. Ind. Acad. Sci.*, (A), 1935, **2**, 303, 342, 477; Teal, G. K., and McWood, G. E., *Jour. Chem. Phys.*, 1935, **3**, 760.
41. Weiler, *Z.*, *Z. f. Phys.*, 1931, **68**, 782; Rousset, J., *Jour. de Phys. et la Rad.*, 1932, **3**, 55; Trumpy, B., *Kgl. N. V. S.*, 1932, **5**, 16, 18 and 47; Bhagavantam, S., *Ind. Jour. Phys.*, 1933, **8**, 197; Veerabhadra Rao, *Proc. Ind. Acad. Sci.*, (A), 1934, **1**, 274; Gross, E., and Vuks, M., *Jour. de Phys. et la Rad.*, 1934, **67**, 130; Sirkar, S. C., *Ind. Jour. Phys.*, 1936, **10**, 75.
42. Gross, E., and Vuks, M., *Nature*, 1935, **135**, 100, 431 and 998.
43. Bhagavantam, S., *Proc. Ind. Acad. Sci.*, (A), 1935, **2**, 63.
44. Sirkar, S. C., *Ind. Jour. Phys.*, 1936, **10**, 109 and 189.
45. Lindemann, F. A., *Phys. Z.*, 1910, **11**, 609.
46. Sirkar, S. C., and J. Gupta, *Ind. Jour. Phys.*, 1937, **11**, 55.
47. Braunbeck, W., *Z. f. Phys.*, 1926, **38**, 549.
48. Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, (A), 1934, **1**, 333.
49. Venkateswaran, C. S., *ibid.*, 1936, **4**, 414.
50. Vuks, M., *Acta Phy. Chim.*, U. R. S. S., 1937, **6**, 11 and 327.

The Vertebral Column of the Anura: Its Bearing on the Classification.

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SINCE the publication of my article on "The Vertebral Column of the Anura,"[1] I have come across some contributions on the subject, published later to Nicholls' work[2] and really too important to be overlooked in a general résumé in this connection. It is only fair to indicate briefly, how this later investigation adds to our knowledge of the vertebral column of this group, and to bring the matter of my article to date.

Apparently, for five or six years, Nicholls' work (1916), an extremely valuable piece of pioneering research though it was, passed off practically neglected. Then in 1922 appeared Noble's masterly study[3] on the Phylogeny of the group, a paper in which a careful scrutiny was made of all the bases of Salientian classification and new myological data were brought forward in order to help to make the classification natural. As far as the vertebral column is concerned, Noble followed Nicholls in essentials, and pointed out that Nicholls' four divisions of the Anura (*viz.*, *Opisthocœla*, *Anomocœla*, *Procœla* and *Diplasiocœla*) "group the frogs and toads into natural categories".[4] According to him, "of all the characters which have been fully investigated, those of the vertebral column seem··· the most important"[5] in a natural system of classification.

Noble examined 113 skeletons, prepared by a modification of Schultze corrosive technique, combined with a staining process. Of this number, fifty specimens belonging to the following species formed exceptions to the conclusions reached by Nicholls; the rest agreed:—

(*a*) *Procœlous Vertebral Column* (instead of a diplasiocœlous one):

Arthroleptis pœcilonotus; *A. variabilis*; *Atelopus elegans*; *A. ignescens*; *A. varius*; *Brachycephalus ephippium*; *Cardioglossa elegans*; *Dendrobates parvulus*; *D. trivittatus*; *D. tinctorius*; *Geobatrachus walkeri*; *Hyloxalus collaris*; *Phyllobates boulengeri*; *P. infraguttatus*; *P. trinitatus*; *Rhinoderma darwinii*; *Sminthillus limbatus*; and *S. peruvianus*.

(*b*) *Other deviations*:

Dendrobates typographus, and *D. tinctorius* fusion of the II + III and VIII + IX.

Phrynobatrachus dendrobates: VIII opisthocœlous; VII biconcave.

Rana cœruleopunctata, *R. christyi* and *R. pipiens* (?) VIII + IX (sacral) fused.

All these exceptions refer to Nicholls' tribe[6] *Diplasiocœla*; and while there can be no doubt that some of them at any rate were abnormalities, the others show that this subdivision is really not strictly circumscribed from the *Procœla*. As a result of these observations, coupled with the nature of the pectoral girdle[7] and the presence of bufonid-like thigh muscles, Noble felt it necessary to create a new family (*Brachycephalidæ*) within the suborder *Procœla*, in order to accommodate the neotropical toads with procœlous vertebræ, and thereby to relieve the families *Ranidæ* and *Brevicipitidæ* (= *Engystomatidæ*)[8] of a great many exceptions[9] to their characteristic, diplasiocœlous type of vertebral column. One should like to mention, however, the following anomalous cases, definitely known still to remain in the suborder *Diplasiocœla* and to point out that a careful scrutiny of the remaining genera would probably add to such cases:

Ranidæ .. *Micrixalus*
Nannobatrachus
Rhacophorus[10]
Ixalus
Arthroleptis
Cardioglossa

Brevicipitidæ: *Rhomobophryne*
Asterophrys[11]

It is hardly necessary to state that a thorough anatomical examination of such exceptional genera alone can bring forward the data, required for deciding whether the suborder *Diplasiocœla*, as at present constituted, should be regarded as a natural group, with some persisting, procœlous forms reminiscent of its origin from procœlous ancestors (Fig. 1), or it should be made homogeneous (as far as the vertebral

Fig. 1. Phylogenetic relationships of the Anura (after Noble, 1931, with slight modifications).
* Probable position of *Megalophrys*.
† Position of procœlous ' diplasiocœla '.

character is concerned) by shifting the exceptions to the suborder *Procœla*. A student of mine is undertaking such a scrutiny of pertinent oriental genera, and I hope that his studies will have much taxonomic importance in this connection.

Of the two exceptions to the suborder *Anomocœla*, recorded by Nicholls, one (*Asterophrys*) is shifted on by Noble in a later work (1931)[12] to the family *Brevicipitidæ*, and the other (*Megalophrys*) still remains within the family *Pelobatidæ*, a case perhaps to be accounted for as retaining the primitive ancestral type of vertebral column.

As the bearing of vertebral characters on the classification of the Anura is at present recognised, we may recapitulate the main points in which Noble's classification (Fig. 2, B) marks an advance over the older, more prevalent[13] one (Fig. 2, A). In the first place, Noble disregards the subdivision of the Anura on the basis of the presence or the absence of the tongue (*Aglossa* and *Phaneroglossa*), and of the *Phaneroglossa* on the character of the pectoral girdle (*Arcifera* and *Firmisternia*); his primary

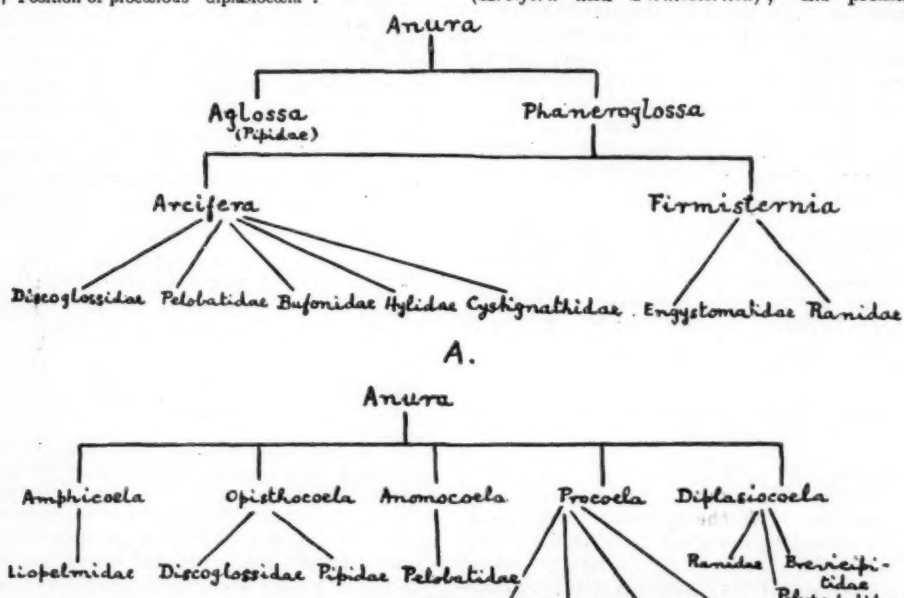

Fig. 2. Scheme of classification of the Anura (A) as prevalent; (B) according to Noble, 1931.

subdivisions rest on the characters shown by the vertebral centra, in accordance with the findings of Nicholls. To the four main divisions of Nicholls, however, he adds[14] a fifth suborder *Amphicœla*, consisting of a single family, *Liopelmidæ* with the two remarkable genera, *Liopelma*[15] of New Zealand and *Ascaphus*[16] of the North-Western United States. These genera, besides showing many apparently primitive features, are unique amongst the tailless Batrachia in possessing two tail-wagging muscles, the *pyriformis* and the *caudalipuboischiotibialis*, even though neither of them has a tail.

Secondly, as a result of the above-mentioned change, Noble includes the aglossid family *Pipidæ*—along with the family *Discoglossidæ* (*Phaneroglossa*), to which it is apparently allied—in one and the same suborder *Opisthocœla*. Such an arrangement was already proposed by Lataste[17] in 1879 and by Blanchard[18] in 1885.

Thirdly, Noble deletes[19] the family *Cystignathidæ* (*Lepiodactylidæ*) and adds the genera of toothed toads to the family *Bufonidæ*. According to him, the toothed forms are more primitive than the toothless ones, but "as they have given rise to toothless bufonids in different parts of the world, it makes a more natural system to group toothed and toothless genera together as a single family." [20]

Fourthly, as already mentioned above, he creates a new family, *Brachycephalidæ*, within the suborder *Procœla* and thus removes the procœlous, neotropical toads from the suborder *Diplasiocœla*.

Fifthly, he distinguishes the diplasiocœlous frogs with intercalary cartilages as a separate family (*Polypedatidæ*)[21] from those in which the digits lack them (*Ranidæ*).

In the end, we must add that Noble's classification, superior though it undoubtedly is to the time-honoured old one, has not so far met with the publicity and acceptance which it deserves. Nieden and Ahl (1923, 1926, 1931),[22] Goodrich (1930),[23] Versluys (1931)[24] and the text-book writers are either not aware of it or are inclined to disregard it. Werner's statement (1931) that "Bikonkave (amphizöle), vorn ausgehöhlte (prozöle) und hinten vertiefte (opisthozöle) Wirbel kommen in nahe verwandten Gruppen vor, sind daher von geringerer klassifikatorischer Bedeutung, als man früher annahm"[25] is apparently in agreement with Gadow's view (1901) that "the systematic value of this pro- or opisthocœlous character has been much exaggerated"[26] and with Boulenger's verdict: "It is therefore clear that this character, however important it may appear at first, is worthless even as a specific character in these[27] Batrachians."[28]

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[1] *Curr. Sci.*, 1936, **4**, No. 10, 744.

[2] Nicholls, G. E., *Proc. Linn. Soc. Lond.*, 1915–16, Session 128, 80–92.

[3] Noble, G. K., *Bull. Amer. Mus. Nat. Hist.*, 1922, **46**, 1–88.

[4] Noble, G. K., *op. cit.*, 13.

[5] Noble, G. K., *op. cit.*, 21.

[6] Noble calls these subdivisions *suborders* not *tribes*.

[7] Arcifero-fermisternal or fermisternal.

[8] It is not intended to make out the exact equivalence of these family names, as conceived by different authors. The family *Engystomatidæ*, as generally understood (Gadow in *Camb. Nat. Hist.*, 1901; Nieden in *Das Tierreich*, Lief. 49, Anura II; Versluys in *Handwörterbuch der Naturwissenschaften*, 1931, article on "Amphibia", etc.), is equivalent to Boulenger's two families, *Engystomatidæ* and *Dyscophidæ* (*Cat. Batr. sal. Brit. Mus.*, 1882; *Enc. Sci., Batr.*, 1910); and to Cope's six families—*Hemicidæ Brevicipitidæ*, *Engystomidæ*, *Phryniscidæ*, *Cophylidæ* and *Dyscophidæ* (*Bull. U. S. Mus.*, 1889, **34**).

[9] *Atelopus*, *Brachycephalus*, *Dendrobates*, *Geobatrachus*, *Hyloxalus*, *Phyllobates*, *Rhinoderma*, *Sminthillus*.

[10] This genus is called *Polypedates* by many workers. However, Ahl (*Das Tierreich Anura III*, 1931) prefers the name *Rhacophorus* Kuhl., and Smith (*Proc. Zool. Soc., London*, 1927) gives strong reasons for the name.

[11] *Asterophrys*, which has opisthocœlous vertebræ, originally belonged to the family *Pelobatidæ*, where it could be regarded, like *Megalophrys*, as showing persistent affinities to the *Discoglossidæ*. However, Noble (*Biology of the Amphibia*, 1931, p. 535) shifts it to the family, *Brevicipitidæ*, where it holds a still more anomalous place.

[12] Noble, G. K., *The Biology of the Amphibia*, McGraw-Hill Book Company, Inc., New York, 1931.

[13] This is the classification generally adopted in text-books. Gadow (*Camb. Nat. Hist.*, 1901), Sedgwick (1905), Nieden and Ahl (*Das Tierreich*, 1923–31), Versluys (1931), etc., all stick to it.

[14] Noble, G. K., *The Biology of the Amphibia*, 1931, 485–86.

[15] *Liopelma* was first described by Fitzinger in 1861 (*Verh. Ges. Wien.*, **11**, 218). Different views have been held about its affinities from time to time. Fitzinger regarded it as closely related to *Telmatobius peruvianus*; Boulenger (1882) placed it in the family *Discoglossidæ*; Nieden (1923) places it in *Cystignathidæ*; Noble, although at first agreeing with Boulenger, later (1924) institutes the family *Liopelmidæ* for its reception. Amongst the recent work on the genus, mention might be made of Wagner's "*Liopelma* studies Nos. 1 and 2" (*Anat. Anz.*, 1934, Bd. 79, Nr. 1/4, 5/6).

[16] Described first by Stejneger in 1899 (*Proc. U. S. Nat. Mus.*, **21**, 899); Regarded by Nieden (1923) as a member of the family *Discoglossidæ*. Its vertebral column is opisthocœlous (Noble, 1922). De Villiers' papers on this genus (*Nature*, 1933, 693; *Anat. Anz.*, 1934, etc.) are interesting contributions on its anatomy.

[17] Lataste, F., "Etude sur le Discoglosse," *Actes Soc. Linn. Bordeaux*, 1879, **33**.

[18] Blanchard, R., "Remarques sur la Classification des Batraciens Anoures," *Bull. Soc. Zool. France*, 1885.

[19] The other families deleted by Noble (1922) are: *Dendrobatidæ*, *Ceratobatrachidæ*, *Genyophrynidæ*, *Hemiphractidæ*, *Amphignathodontidæ*, *Dendrophryniscidæ* and *Dyscophidæ*.

[20] Noble, G. K., *The Biology of the Amphibia*, 1931, 496.

[21] Noble, G. K., "The value of life-history data in the study of the evolution of the Amphibia," *Ann. Acad. Sci., New York*, **30**, 111. The name *Polypedatidæ* is based on the genus *Polypedates*, which had better be called *Rhacophorus* (see foot-note 10, above). Perhap the family should be called *Rhacophoridæ*.

[22] Nieden, Fr., "Anura I and II", *Das Tierreich*, Lief. 46 (1926) and 49 (1926); Ahl, E., "Anura III," *Das Tierreich*, Lief. 55 (1931).

[23] Goodrich, E. S., *Studies on the Structure and Development of Vertebrates*, London, 1930, xxi.

[24] Versluys, J., "Amphibia" in *Handwörterbuch der Naturwissenschaften*, 1931, 296–97.

[25] Werner, Franz, "Dritte Klasse der Craniota. Dritte und zugleich letzte Klasse der Ichthyopsida. Amphibia Lurche." Kukenthal's *Handbuch der Zoologie*, Bd. 6, zweite Hälfte; zweite lief., p. 20.

[26] Gadow, H., "Amphibia and Reptiles", *Camb. Nat. Hist.*, 1901, **8**, 19.

[27] He is referring to the species of the Genus *Megalophrys*.

[28] Boulenger, G. A., "A Revision of the Oriental Pelobatid Batrachians (Genus *Megalophrys*)," *Proc. Zool. Soc. London*, 1908, 408.

A Note on Section Cutting of Insects.

By Durgadas Mukerji,
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IN Rolles Lee's (1928, p. 510) Microtomist's Vade-Mecum, it is stated that the sectioning of insects is a grim business. Numerous methods of microtomy of insects are reported but none can claim to have a wider range of application (Kennedy, 1932, p. 40), nor is suitable for routine work. It becomes therefore, increasingly, difficult for insect anatomist or histologist in selecting a fixative well suited for a particular material, without the laborious task of giving trial to several of the known methods. Eltringham (1930, p. 93) remarks that there is no satisfactory method of softening chitin without at the same time destroying the structure of the softer internal tissues.

The following fixative which I prepared, gave me satisfactory results in my investigations of the anatomy and histology of insects such as collembola, ants, beetles, etc., perfect sections of the entire insects being obtained as will be seen from photomicrographs given in some of my papers cited in the reference. To enable the beginners interested in the study of insect morphology, to do away with some of the common difficulties which generally hamper the progress of work, I give below the method which we have adopted in our laboratory.

1. Specimens are fixed in the following mixture overnight:

Saturated solution of picric acid in 90% alcohol	..	75 parts
Formalin ..	..	25 „
Strong nitric acid	..	5 „

This fixative as I have already reported (1930, 1932) is a modification of Bouin's fluid, the acetic acid being replaced by nitric acid which it will be noticed had been used before by previous workers as a constituent of some of the fixatives for softening of the chitin in the insect's body. This fixative is useful for embryological as well as for general histological work; and sections are stainable by Hæmatoxylin, Borax carmine and Mallory's mixture (Saüra-fuchsin, Orange G, and Wasserblue). It is, however, inapplicable for cytological investigations; it causes clumping of the chromosomes. The specimens readily sink in the fluid which fixes and softens chitin without damaging the softer tissues. Specimens can be left in the fluid for 12–24 hours; but where a longer time is required for softening chitin that is strongly developed, corrosive sublimate may be added to this mixture so as to prevent maceration of tissues, or the specimens be primarily fixed for a short time in any other fluid such as Bouin's and secondarily transferred to this fluid, as double fixatives are sometimes found advantageous. Where quick penetration is required, suction pump may be used at the time of fixation, or punctures should be made in the specimens if they are very large in size. Often alternate heating below 60°C. and cooling of the fixing fluid containing specimens, are sufficient for driving out air from the tracheæ. Specimens which float in the fluid even after the above treatment should be rejected. In case of heavily chitinised insects it is safer to employ newly emerged specimens.

2. Washing is done in 70% alcohol and dehydration by passing through 90% to absolute alcohol, several changes of alcohol being given.

3. Clearing is done in Cedar Wood Oil.

4. If the specimens are not very strongly chitinised, paraffin sections can be taken, but it is always safe to resort to double embedding although the latter process takes a longer time varying from two to six weeks. In case of double embedding the specimens are soaked for a minute or two in clove oil, and are transferred to a thin and then to a thick solution of celloidin dissolved in clove oil.

5. The celloidin mass containing the specimen, after hardening in chloroform and next in xylol, is transferred to the molten paraffin in the oven. The procedure is the same as in general histology. We prefer paraffin of melting point of 58–60°C. and contrary to orthodox views, a longer bath in the molten paraffin. Hard chitinous substances are cut thicker than 10μ, and to ensure a continuous ribbon the block is coated with a thin layer of soft paraffin. A sharp razor is essential for the success.

6. A difficulty often experienced is that the chitinous parts become loose and float away from the slides as soon as sections are passed from xylol after removal of paraffin, to the absolute alcohol, or, to water after descending grades of alcohol, even when the slides were properly smeared with Mayer's albumen, and good care had been taken in flattening and drying sections. This can be avoided by coating the sections after removal of paraffin by xylol, with a very thin layer of celloidin, by dipping the slide in a thin solution of celloidin dissolved in absolute alcohol and ether. The sections are passed to the descending grade starting from 90% alcohol. In the upgrade passage of dehydration after staining, the sections are quickly passed through absolute alcohol, and clearing is done either in creosote or in a mixture of clove and cedar wood oils in equal proportions. The sections are immersed in xylol before mounting in canada balsam.

Bolles Lee, "Microtomist's Vade-Mecum," London, 1928.

Eltringham, H., "Histological and illustrative methods for entomologists," Oxford, 1930.

Kennedy, C., "Methods for the study of the internal anatomy of insects," Ohio, 1932.

Mukerji, D., *Arch. Zool. Expt. Gen.*, 1930, **70**, Fas. 5.

Mukerji, D., *Recd. Ind. Mus.*, Calcutta, 1932, **34**, Pt. I.

Mukerji, D., and Bhuya, *Jour. Morph.*, Philadelphia, 1937, **61**.

Murray, J., *Jour. Roy. Micros. Soc.*, London, 1937, Ser. III, **58**, pt. I.

LETTERS TO THE EDITOR.

A General Coefficient of Statistical Relationship.

Suppose two variables x and y are related by the equation $x = ky + z$, where k is a constant and z another variable which is statistically independent of y. Then the relationship between x and y is usually expressed by means of the correlation coefficient between them. This is not a general coefficient in that the test of significance of the correlation coefficient calculated from a sample is not accurate unless both x and y are normally distributed. The coefficient described below is quite general in this sense and hence is better than the correlation coefficient.

Relation-Coefficient.—In the x, y population let us consider first the values of x only. Let the median for the x population be denoted by $\mathfrak{M}_x$, see (1). We subtract this value from each of the x values, that is to say, we replace the x values by their departures from $\mathfrak{M}_x$. Similarly we replace the y values by their departures from $\mathfrak{M}_y$. Each individual in the x, y population will now consist of two departures. We count the total number, n_1, of individuals having departures of the same sign, each individual containing one or both departures zero being counted as $\frac{1}{2}$. Similarly we count the total number, n_2, of individuals having departures of opposite sign. If n be the total number of individuals in the whole population, then a general coefficient of statistical relationship, which may be termed "relation-coefficient" and denoted by ৲,* is given by

$$\text{৲} = \frac{n_1 - n_2}{n} \qquad \text{(I)}$$

n is, of course, equal to $n_1 + n_2$.

It is easy to see that ৲ may have any value from $+1$ to -1, and is zero when the variables are statistically independent of each other. In this respect it resembles the correlation coefficient.

In the case of a sample, we use $\mathfrak{M}_x'$ and $\mathfrak{M}_y'$ the medians of the x and y values in the sample, see (1), and proceed as above. We shall denote the relation-coefficient in a sample by ৲′.

A Test of Significance for ৲.—Suppose our sample has n pairs of values x_1y_1, x_2y_2, ... and x_ny_n. ৲′ is easily determined. To test the significance of ৲′ we proceed as follows. Let us consider the values x_1, $x_2 \cdots x_n$. Suppose we use P as our limit for random chance. We now find the limits for $\mathfrak{M}_x$ using $\sqrt{P}$ as the limit for random chance as explained in (1). Let the limits be $\mathfrak{M}_x^{(1)}$ and $\mathfrak{M}_x^{(2)}$ in the order of ascending magnitude. Similarly, on the same limit $\sqrt{P}$ we find the limits $\mathfrak{M}_y^{(1)}$ and $\mathfrak{M}_y^{(2)}$ for $\mathfrak{M}_y$. Let $\mathfrak{M}_y^{(1)} < \mathfrak{M}_y^{(2)}$.

Arguing in a manner similar to that given in (1) we see that when x and y are statistically independent of each other and only when $\mathfrak{M}_x^{(1)} \leqslant \mathfrak{M}_x \leqslant \mathfrak{M}_x^{(2)}$ and $\mathfrak{M}_y^{(1)} \leqslant \mathfrak{M}_y \leqslant \mathfrak{M}_y^{(2)}$ our sample could have been obtained from the x, y population by random chance for which the limit is P.

We use $\mathfrak{M}_x^{(1)}$ and $\mathfrak{M}_y^{(1)}$ and find the departures in our sample. It is sufficient if

* ৲ is a Sanskrit letter pronounced like "ru" in "run", but with the vowel sound slightly more prolonged.

only the signs are given. We now calculate τ from equation I. Using $\overline{\pi}_y^{(2)}$ instead of $\pi_y^{(1)}$ we get another value for τ. Similarly with $\pi_x^{(2)}$ and $\pi_y^{(1)}$ and $\pi_y^{(2)}$ separately we get two more values of τ. We now take the highest and the lowest of these four values. Let τ_1 and τ_2 be these values. We will call the interval from τ_1 to τ_2 (including the end values) the P interval for τ. In a similar manner we can obtain an interval for τ on any other limit for random chance.

A General Test of Significance of τ'.—Our test of significance may now be stated thus:

Using some limit for random chance we calculate the interval for τ as explained above. If this interval does not contain zero, τ' is significant, and if zero be an end value of this interval τ' may be considered to be just significant.

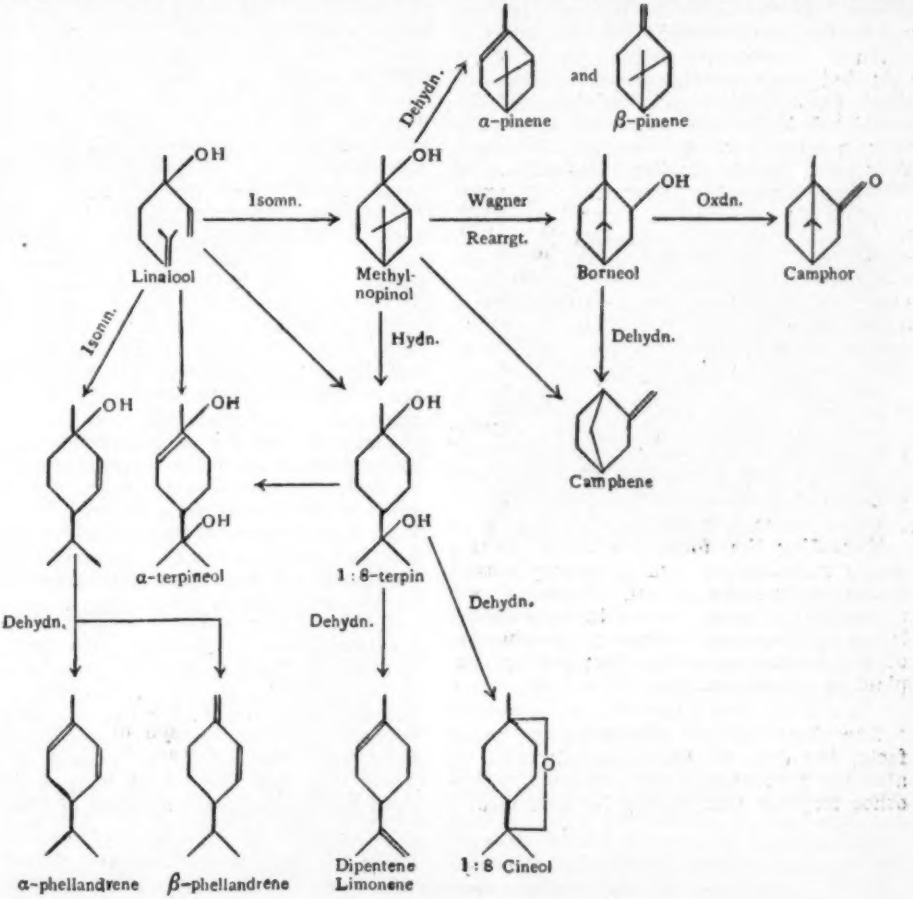
It is easy to see that this test is quite general, that is, it is applicable to all samples irrespective of the frequency distributions in the populations, from which the samples were obtained. Details will be published elsewhere.

Poona 5, S. R. SAVUR.
July 8, 1937.

[1] S. R. Savur, *Proc. Ind. Acad. Sci.*, 1937, **5**, 564.

The Biogenesis of the Terpenes.

ADOPTING the view that, in general, the widely distributed terpenes are only indicative of the ease with which the biological



reactions in the plant proceed in the direction of their formation and not suggest that they are functioning as the progenitors of other terpenes, a study of the relative abundance of the terpenes should serve as a clue to understand the biogenetic tendencies in the plant regarding the synthesis of the terpenes. A census taken with this idea furnishes the following data: α-pinene occurring in 375 oils; cineol in 260; limonene or dipentene in 160; phellandrene (α or β) in 126; borneol in 110; camphene in 85; camphor in 70; α-terpineol in 165; β-pinene in 60 and the others are all occurring in smaller number of oils (the aliphatic terpenes being omitted).

From a knowledge of the general reactions of the various trpenes in our "test-tube experiments" and an analysis of their 'molecular architecture', it is suggested (after trying various possibilities) that linalool can satisfactorily be considered to be the precursor of all the abovementioned widely occurring terpenes. Very significant is the suggestion of Ruzicka[1] that the formation of small amounts of camphor and borneol observed by Winagradov[2] when linalool is heated with activated aluminium, takes place through the intermediate methylnopinol, the formation of which from linalool by a double ring closure is now considered to be the trigger reaction in the production of the widely distributed bicyclic terpenes.

The scheme given above shows the probable "general direction of the processes" in the formation of the widely distributed terpenes in nature.

Regarding the formation of the widely distributed linalool (which is very closely related to geraniol, citral, citronellol and citronellal) it seems better to defer speculating till the exact (botanical) mechanism of the formation of the terpenes in the plant is understood.

The above scheme accommodates many facts, the detailed discussion of which as also the mechanism of formation of the other terpenes will shortly be published.

The author thanks Dr. P. C. Guha for valuable suggestions.

K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
May 31, 1937.

[1] *Ann. Rev. of Biochem.*, 1932, **1**, 583.
[2] *Ber.*, 1931, **64**, 1991.

Physiology and Function of the Oesophageal Diverticulum in Blood-sucking Psychodidae.

IT has been suggested by the previous workers on this line that the general function of the œsophageal diverticulum is that of a crop or a food reservoir, from which the food material is regurgitated back into the alimentary canal at intervals. The following experiment was done to determine as far as possible the exact function of the diverticulum. Sterile *Phlebotomus argentipes* Ann. and Brun. kept in different cages were allowed to suck the free-fluid from cotton-wool soaked in the following solutions, *viz.*, 5% glucose in distilled water stained with methylene-blue, 5% glucose with a colloidal suspension of Indian ink and N.N.N. culture with flagellates. The midges were picked up after they were fully fed and dissected immediately. It was found in the case of flies fed on glucose-methylene-blue solution that the diverticulum was bloated up considerably with the fluid while in the case of those fed with the fluid with a suspension of Indian ink some of the finer particles reached the diverticulum along with glucose; the coarser particles, on the other hand, being diverted to the mid-gut. The experiment with the N.N.N. medium with flagellates showed the presence of flagellates both in the diverticulum and the mid-gut. Apparently, the mid-gut was reached after the diverticulum was already full. In the control experiment with flies fed on an animal it was found that flies bloated up with a blood-meal seldom showed any trace of blood in

the diverticulum. The author thus opines that in all probability the midges have a selective reflex action, not altogether mechanical, by which they can by closing or opening the valve of the diverticulum, divert a particular ingested fluid to a selected reservoir or reservoirs wherefrom they are regurgitated and absorbed when needed. It is quite likely that this closing of the diverticular valve by a reflex action takes place only at the time of a blood-meal by the actual penetration of the proboscis and the consequent folding in of the labium which is quite distinct from the "licking of free surface fluid" which, as the previous experiments show, diverts most of the ingested fluid to the diverticulum. The author also found that in the case of wild flies collected freshly fed in nature, blood was seldom found in the diverticulum and hence diverticulum, at least in these midges, cannot, in the true sense of the term, be called a food reservior. On the other hand, there are evidences of the presence of a colourless fluid in the diverticulum of wild-flies apparently, in the process of regurgitation. The author thus concludes that in nature the diverticulum of a blood-sucking *Psychodid* contains a fluid of lesser consistency than the blood traced in the mid-gut of a fly and that this fluid, at times, is regurgitated into the alimentary canal of the midge to restore or alter the physico-chemical properties of a blood-meal for a specific purpose.

S. MUKERJI.

Karachi City,
June 16, 1937.

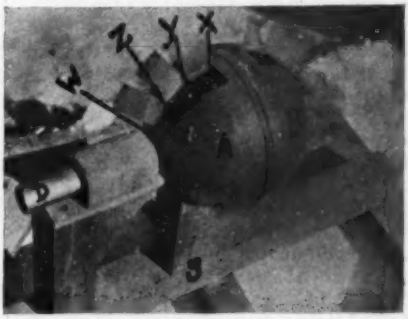
An Apparatus to Determine the Coefficient of Energy Absorbed by a Leaf.

THE problem of energetics of a leaf though very important has been dealt with by comparatively few workers. Brown and Escombe,[1] the premier workers in the field, have tried to establish a relation between the physiological activities of a leaf and the energy absorbed by it. In finding out the energy absorbed by a leaf they took for granted that the loss due to reflection from the surface of a leaf is neglegible. Jorgensen and Stiles[2] cast a doubt on this hypothesis and brought out the fact that even a black cloth reflects one per cent. of the incident energy.

Coblentz,[3] Shull[4] and others have made spectrometric measurements of light incident on, transmitted by and reflected from a leaf. They all agree that the reflected energy is about 10 per cent. of the total incident energy.

In the present state of our knowledge about the problem the author thought it desirable to construct an apparatus which would give an accurate idea of the amount of energy absorbed by a leaf. Fig. 1 gives a vertical section of the apparatus *in situ*, shown in the photograph.

A and B are two hemispheres, A fitting into B as shown in Fig. 1. The hemisphere A has an aperture at its apex to admit a beam of light coming through the tube D. A removable circular plate C is fitted in



A—Hemisphere receiving the light reflected from the surface of the leaf L. *B*—Hemisphere receiving the light transmitted by the leaf L. *D*—Tube admitting a beam of light incident on the leaf L. *X*, *Y* and *Z* areas cut on the surface of the hemisphere A on which the photronic cell is placed. *W*—Surface of the hemisphere, the energy falling on which cannot be measured directly. *S*—Support.

flush with the edge of the hemisphere A. The plate C has a circular aperture at its centre. This aperture is in line with the tube D and the aperture in the apex of the hemisphere A. The apparatus is supported on a wooden frame S (Fig. 1).

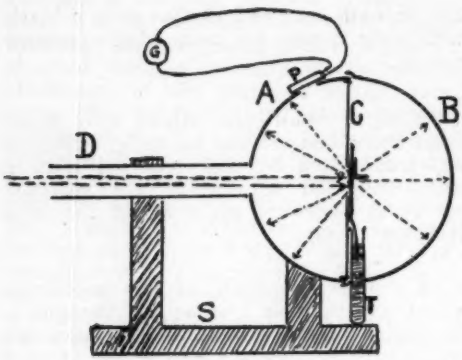


Fig. 1.

Vertical section of the apparatus *in situ*.

A—Hemisphere receiving the light reflected from the surface of the leaf. *B*—Hemisphere receiving the light transmitted by the leaf L. *C*—Circular plate with a hole at its centre fitting in flush with the edge of the hemisphere A. *D*—Tube admitting a beam of light incident on the leaf L. *G*—Galvanometer. *L*—Leaf fixed on the hole in the plate C. *P*—Weston's photronic cell placed on an area cut in the hemisphere A and connected with the Galvanometer G. *S*—Support. *T*—Tube containing water in which the petiola of the leaf L dips.

A beam of light admitted through the tube D passes through the aperture at the apex of the hemisphere A and falls on the leaf L fixed on the aperture in the plate C. The petiole of the leaf dips into a tube T containing water. A portion of the light incident on the leaf L is reflected back into the hemisphere A, another portion of the incident light is transmitted through the leaf into the hemisphere B and the remaining portion is absorbed. On account of the roughness of the surface of the leaf, both the reflected and transmitted portions of light are scattered in all directions and so fall on the inner surfaces of the hemispheres A and B respectively.

Suitable portions of each of the hemispheres are cut off along the longitudes of the hemispheres as seen in the photograph. The light falling on these areas is measured by placing on them a Weston's photronic cell P (Fig. 1), connected with a sensitive galvanometer G, and recording the deflection of the galvanometer. From these readings the total amounts of light reflected and transmitted by a leaf are calculated in the following manner.

It has been observed by the author in his preliminary experiments, that the reflected and transmitted energies are not uniformly distributed over the whole inner surfaces of the hemispheres A and B, but are distributed symmetrically round the axis of the hemispheres, which is perpendicular to the central plate C. Supposing the hemisphere A is rotated round its axis, the cut area x on its surface will describe a circular strip, say x'. Similarly, the areas y and z will describe circular strips y' and z' respectively. On account of the symmetrical distribution of the reflected and transmitted energies round the axis of the hemispheres, the intensity of light falling on the cut area x is the same as on a similar area on circular strip x'. In order to find out the amount of energy received on x' the reading of energy falling on the cut area x is multiplied by the factor

$$\frac{\text{area of the circular strip } x'}{\text{the cut area } x}.$$

In a similar manner the amounts of energy falling on y' and z' are found out.

The energy falling back on the aperture at the apex of the hemisphere, and also falling on the small strip w' bounding the aperture cannot be measured directly. It can only be estimated by the method of extrapolation. According to this method when we know the intensities of energy falling on the consecutive areas x, y and z the intensities of energy falling on the immediately next area (consisting of w' and the aperture at the apex of the hemisphere) can be estimated. From this intensity the amount of energy falling on this area can be estimated. The results of the amounts of energy falling on these different areas when added up, give the total energy reflected by the leaf.

In the case of transmitted energy readings of energy falling on areas of the hemisphere B, similar to x, y, z and one at the apex of the hemisphere B, are taken, and from these the total transmitted energy is calculated directly.

The total incident energy is determined by replacing the leaf by a screen of known transmissibility and collecting the light transmitted in the same manner.

The total time required for taking all the readings necessary to find out the coefficient of absorption of energy of a leaf, is never more than three minutes, and it may be presumed that the reflecting and transmitting power of the leaf with its petiole dipped in water, does not alter materially during this period.

Having found out the incident energy (I), the reflected energy (R) and the transmitted energy (T) the coefficient of absorption (C) can be found out by the equation

$$C = \frac{I - (R + T)}{I}.$$

A detailed study of the leaves of several species has been made with the help of the above apparatus and some interesting results have been noted. Further details of the apparatus and the results obtained with it will be published in due course.

U. K. KANITKAR.

12, Ganesh Wadi,
Poona 4.

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[1] Brown, H. T., and Escombe, F., *Proc. Roy. Soc.*, (Lond.), (B), 1905, **76**, 69-111.

[2] Jorgensen, I., and Stiles, W., *Carbon Assimilation*, p. 141.

[3] Coblentz, W. W., *Bull. Bur. Stand.*, 1912, **9**, 283-325.

[4] Shull, C. A., *Bot. Gaz.*, 1929, **87**, 583-635.

Soil Fertility and the Role of Trace Elements.

IN recent years, a great number of papers have been published on soil fertility studies and in some of these, the factors that influence the plant growth are discussed. These experiments tend to show that some of the elements needed only in small quantities, *e.g.*, Mn, Ti, B, Zn, exercise marked influence on plant growth. Among the various workers who have contributed to this line of research mention may be made of Bertrand, Warrington, Sommer, Subrahmanyan, Dhar and Horner. The great importance of traces of Manganese for the plant has been demonstrated by McHargue, McLean, Kelley and Gerrestsen. Kelley, while studying the soils under cane cultivation in Hawaii, observed the presence of large quantities of Mn and Ti, while Gerrestsen believes that Manganese intensifies photosynthesis by accelerating the oxidation processes connected with the photochemical reactions in the leaf, shortage of Manganese resulting in retarded carbon dioxide assimilation. In carrying out a study of the physical and chemical properties of some typical soils from cane-growing areas, which were kindly supplied to the author by the Superintendent of the Government Agricultural Farm, Anakapalli, it was felt that valuable information might be obtained by the spectrographic examination of these soils, as it would enable one to detect and identify all the metallic elements contained in them without allowing even the rare ones to escape detection. The arc spectra of many representative soil samples have been photographed. Besides the elements Na, K, Cu, Mg, Ca, Al and Si which can be detected by chemical analysis as well, the trace elements Zn, Ti, Mn and B could be indubitably detected and identified, while Be is suspected. By comparing the spectra of these soil samples with those of a series of suitable ratio powders of known composition, attempts have been made to determine the proportion of the minor constituents. The Manganese content of the majority of the fertile soils was found to range from 0·04 to 0·15 per cent., while the value of Zinc ranged from 0·03 to 0·06 per cent. Though no very definite statement can be made as to the relative importance of the trace elements, the preliminary experiments tend to show that while these elements are needed only in small quantities, they may not be present in sufficient amounts in available form. An outstanding feature of this spectrographic examination is the predominating proportion of Manganese and Zinc in some fertile soils, while all the soils of the tract seem to be comparatively rich in Silicon. Further experiments are in progress.

A. L. SUNDARA RAO.

Kodaikanal,
June 1937.

REVIEWS.

Chemistry of Food and Nutrition. By Henry C. Sherman, Ph.D., Sc.D. Fifth Edition. (The Macmillan & Co., Ltd., New York), 1937. Pp. x + 640. Price 12*s*. 6*d*.

The time has come when scientists ought cheerfully to accept the reproach of descending below the dignity of science if they could only succeed in writing their message so as to be read in every cultured home. We emphasise the paramount importance of the application of the results of research to the problems of humanity and civilisation whose partcipators enjoy neither leisure, nor health, nor happiness must be a reproach to the generni progress of knowledge. How can there be peace and harmony in any community in which a large percentage of people are ill-fed, ill-clothed, ill-tended and ill-housed? In its attempts to discover whether God is a mathematician or an engineer, science has not been equally busy how to make the creatures in his own image healthy and contented. We have precise knowledge about the physical and chemical constitution of distant stars, but do we have equally precise knowledge of the child mind, and do we have the power of directing and controlling its destiny? In dealing with the human mind, our attitude seems analogous to the proverbial horse whom one man can lead to water but twenty cannot make him drink.

Dr. Sherman's book is a splendid contribution to the science of nutrition. Although the book is intended to meet the requirements of college classes, its scope and usefulness extend far beyond the interests of students and the purpose of public examinations. It is one of the rare text-books on science which statesmen and housewives will find indispensable in the discharge of their tasks. The chief attraction of the book is the wealth of carefully tested information on all aspects of the chemistry of food and nutrition and the engaging graces of literary scholarship. It is increasingly recognised that the chief value of science to mankind does not consist in the static description of its results, but chiefly in the study of their application in the promotion of people's health and prosperity. The book provides an adequate description of the structural chemistry of the proximate principles found in food, but the emphasis is laid on the consideration of the functioning of these substances in nutrition. Nutrition is the functional aspect of the study of food chemistry, and therefore its dominant aspect from the point of view of presentday science occupies the greater part of the book.

The book comprises 27 chapters which present an eminently clear and precise account of the principles of the chemistry of food and nutrition from the standpoint of the study of chemistry and from the point of view of the needs of the community, which obviously must underlie not only our judgment of the values of the different articles of human diet, but also the use of food for the advancement of health. According to the present indications, the results of research work in food chemistry might, in a small part, stimulate the production of synthetic foodstuffs, and much more largely, the increase of crops and farm animals; but the principal contribution which the latest development of this branch of knowledge will be in the direction of furthering human welfare and progress through the more scientific use of food.

Controvertial views are not neglected. The discussion on them just indicates that some of the views are capable of more than one interpretation, and that on others fresh evidence is available. But the most valuable part of the book, which is also the most difficult task for presentation is the exposition of the latest findings of the newer chemistry of nutrition in a way which puts them in their proper value and importance. The range of subjects included in the book is no doubt wide, and each chapter can be read independently, and the reader can take any topic, without being obliged to read the previous chapters. Still the student using the book for serious class work, will find that several chapters form a coherent whole, and at the end of each chapter are lists of references which put the reader in touch with the significant literature so valuable for students

seeking for fuller information. In the four Appendices given at the end of the book much that is new of the data on mineral contents and vitamin values of foods is given, and in several instances, there are here presented for the first time average of a new order of precision with statistically determined probable errors and coefficients of variation.

The book is superb, its value as a scientific treatise is only excelled by its usefulness for the enlightened general public.

Origins of Clerk Maxwell's Electric Ideas as Described in Familiar Letters to William Thomson. Edited by Sir Joseph Larmor. (Cambridge University Press), 1937. Pp. 56. Price 3/6 net.

Theoretical Physics has throughout its history been alternating between the action-at-a-distance view and continuous action theories. Faraday and Clerk Maxwell turned electrical science from Coulomb and Ampère's distant action ideas into the conception of a field of continuous action. Prof. Max Born has, in recent times, attempted to develop a unified field-theory which is designed to find a natural place for electrons and protons in its logical growth. At such a time a perusal of the mode of origin of Maxwell's electric ideas is bound to be stimulating and diverting. Maxwell's attempts to build up a dynamical basis for his field theory from a detailed mechanical picture of the ether, present, however, a radical contrast to modern methods which start from Hamiltonians and Lagrangians with frankly no apology for their introduction. The letters brought together in the present connection are not many of them concerned with electricity at all. We are given a glimpse into Maxwell's, many-sided investigations — his theory of bending of surfaces, colour vision and so on, the electrical portion being about a third of the whole. The Editor has an excursus at the end on the idea of entropy. We should have welcomed more of the illuminating remarks of Sir Joseph Larmor indicating the connection of many of the allusions in the letters with other available papers of Maxwell and Kelvin, for these remarks will soon become important historically on account of Sir Joseph's peculiar position as a connecting link between classical and modern Physics.

T. S. S.

Physics, an Introductory Text-Book. By H. J. Taylor Humphrey Milford. (Oxford University Press), 1937. Pp. x + 448. Price Rs. 5.

This book is in a sense the lineal descendant of the many excellent text-books of Theoretical Physics which have been appearing in increasing numbers in recent years, as for example those of Arthur Haas, Joos, Leigh Page, Wilson, Westphal, Houston and others, but it aims at a much lower standard which is stated by the author to be that of the Bombay Intermediate Examination. Like them it is modern in outlook, pruned of experimental details, compressed and cut down to the minimum compass by a rearrangement of topics which avoids repetition at all costs. Like them also it can only serve as a guide for more detailed study and as a compact summary for recapitulation. Its modern outlook is evidenced by brief references to the Theory of Relativity, Andrade's work on the striations in a Kundt's tube, crystal structure, shape and orientation of the molecules of organic compounds, acoustics of buildings and so on. There is a number of beautiful photographs such as those of ripples, biprism fringes, model of soap molecules and so on. The emphasis is judiciously thrown on the cardinal principles, and often, as in his remarks on music, the author is very interesting. But the explanations are everywhere meagre and appear to be unwillingly inserted out of sheer necessity. Experimental details are almost entirely wanting, and it is doubtful whether such a separation of theory and experiment is desirable at the Intermediate stage. Though in this way the book has been made very compact, the student will necessarily require another text for practical physics and then there is no guarantee that the experimental course will correspond to the treatment in this book. Even if the author of this book were to prepare a companion volume, much avoidable repetition of the theory will become necessary. If one looks at the amount of theory included in the Wien-Härms' *Handbuch der Experimental physik*, one will be convinced that a divorce between theory and practice is impossible. Another departure from usual practice noticeable in the book is the amount of Kinetic Theory and Physical Optics included in spite of the fact that the Calculus

is excluded, as also the complete absence of worked examples. The few examples given at the end of the book cannot compensate for the lack of exercises on the individual chapters. Though the tendency to compactness is due to the modern necessity of passing on more and more knowledge to the student in the same interval of time as before, the student at the Intermediate stage cannot be expected to fatten exclusively on these compressed tablets of knowledge, so entirely freed from bulk material.

The author has avowedly aimed at avoiding certain "spurious definitions" but we cannot say that his attempt is an unqualified success. It is an impossible task to define fundamental quantities strictly, since they cannot be made to depend on simpler concepts. The best course seems to be to start from intuition and then make the idea more precise as soon as the necessity for greater precision has been shown to exist. The author criticises the statement that "mass is the quantity of matter" but says that "the mass of a kilogram is the amount of matter which has the same weight as the standard kilogram". He also says that the gravitational pull exerted by the earth on a body compared with the pull at the same place on the standard kilogram, gives the mass of the body. Does this mean that mass is a pull or that it is a ratio of two pulls? Immediately afterwards the word 'force' is introduced without any definition at all. The author criticises the statement that "temperature is the degree of hotness" on the score that the method of determining the degree of hotness is not clear. His definition that "temperature is the indication of a standard thermometer" is equally faulty since the definition does not prescribe how the standard thermometer is to be constructed. It is a wonder he does not define force as the indication of a standard dynamometer.

We do not understand such statements as "a hypothesis is the opposite of abstraction," "observing a law," "the length of a spring gives the force extending it," "Boyle's law is a more general statement of Charles' law" and so on. Instead of proving that the pressure at a point in any liquid is the same in all directions, the author proves the less useful theorem that in a weightless fluid the pressure is the same at all points. We find absolutely no precedent for defining specific gravity as the weight of a unit volume and contrasting it with relative density. In the description of Fig. 65, the letter P is mentioned but is not to be found in the figure. The formula $n = \frac{2}{l}\sqrt{\frac{F}{\rho}}$ is wrong and should be $n = \frac{1}{2l}\sqrt{\frac{F}{\rho}}$ and correspondingly the previous statement that $k = 2$ should be $k = \frac{1}{2}$. The closed end of a pipe is wrongly called a pressure node on p. 126. In finding the specific heats of liquids by the method of cooling we take equal volumes of liquids and not equal weights. The convention of signs adopted gives the same formula for mirrors and lenses and this, being contrary to current practice, is likely to cause confusion. To say that magnets are made of iron is misleading. The term "intensity of magnetisation" is abruptly introduced on p. 321 without any definition; the explanation of the term occurs much later. The statement on p. 373 that "the current in the wire flows from the lead plate to the peroxide plate" in an accumulator cannot be correct. The full path of the rays in a compound microscope is not correctly shown on p. 269. We find 's' for 'is' on p. 249. On p. 420, Q. 24, 432 cm. should be 432 mm.

Although we have indulged in a lengthy criticism, our intention is only to see that a good book is made better. The sections on photometry, polarisation, molecular structure of solids and centres of pressure are admirable. The whole outlook of the book is also fresh and stimulating. We can only invite the author to lay students under a deeper debt by rendering the exposition clearer even at the cost of some prolixity.

T. S. S.

The Metabolism of Living Tissues. By Eric Holmes. (Cambridge University Press), 1937. Pp. x + 235. Price 7*s.* 6*d.* net.

The object of the biochemist is to interpret the various activities of life in terms of chemical reactions knowing of course as a biologist that one of the fundamental characteristics of life is growth and change. The starting point of the biologist is the living cell in which, however, the chemist discovers

a series of biochemical reactions. Undoubtedly this investigation and the interpretation of the interplay of the chemical reactions is largely limited since the cell is so susceptible to the change in environmental conditions like temperature, oxygen-content, etc. Dr. Holmes, the author of this fascinating book under review, leads us into a domain where biochemical discoveries have been of recent origin and deals with them in such a lucid manner that the beginner "will acquire an understanding of the aims and present position of the science which will add greatly to the interest of his later studies." Some of the chapters included in the book like Enzymes, Hormones, Vitamins, Oxidations, the Liver and Kidney Metabolisms, make extremely interesting reading. In dealing with enzymes, the author points out that there are several classes of them, some of which, at any rate, can be isolated as pure substances, *e.g.*, the proteolytic digestive enzymes, while others are difficult to be dissociated from the cells. The condition under which energy reactions take place is also described. It is noticed that in these reactions besides the association of the enzyme and its substrate with suitable conditions of temperature and pH, there is a third factor called "co-enzyme"—a substance which is frequently thermostable and often non-colloidal. By a set of careful but difficult experiments on mammals, it has been conclusively proved that liver is the chief site of the formation of urea, though tissues other than the liver may also contribute in very small proportions. For the formation of urea, ammonia and CO_2 are necessary and probably some ammonia is brought into the liver from exterior since it is not all made locally. The little that is manufactured in the liver is by the deamination of the amino-acids. The chapter on the nervous system could have been certainly enlarged. After describing the dependence of the brain upon the oxygen supply derived from the blood brought by carotid and vertebral arteries, the author points that besides O_2, the brain must also have an adequate supply of glucose which also it draws from the blood. A brief account of the chemical action of the drugs on the nervous system is also given.

In conclusion, Sir Gowland Hopkins rightly points out in his Foreword that "Characteristic of his presentation of facts and inferences is a continuity which encourages the reading of the book from cover to cover."

The get-up of the book is excellent.

L. S. R.

Silicate Analysis—A Manual for Geologists and Chemists with chapters on Check Calculations and Geochemical Data. By A. W. Groves. With a Foreword by Prof. Arthur Holmes of the University of Durham. (Thomas Murby & Co., London), 1937. Cloth : Price, 12*s.* 6*d.*

There is a very voluminous but scattered literature on analytical methods. Standard methods are being constantly improved upon and new methods are being tried out for increasing the accuracy and for making the procedure simpler and less liable to errors. A number of special treatises confining themselves to particular elements, compounds, natural or artificial substances have been published, and several comprehensive handbooks such as those of Scott, Mellor, Treadwell (Hall), Hillebrand and Lundell, are now available which may be considered indispensable in any analytical laboratory.

During the last few decades specialisation has so far advanced as to call for separate works on methods of analysis of silicates and silica products. Industries such as glass, ceramics, refractories, cement, etc., have to exercise as strict analytical control on their raw materials and finished products as the metallurgical industries. In addition, the development of mineralogy and petrology depend in some measure on the thorough understanding of the composition of minerals and rocks; similarly, the elucidation of geochemical and petrogenetic problems need the help of quantitative chemical data.

In this special field of silicate analysis the works that have so far appeared in English are from chemists with a long background of experience in the well-equipped laboratories of the United States Geological Survey. W. F. Hillebrand's well-known *Analyses of Silicate and Carbonate Rocks* now available as Bulletin 700 (U.S. Geol. Surv.) grew out of the earlier notes which accompanied a publication of collections of analyses done in those laboratories. This was followed by H. S. Washington's *Chemical Analyses of Rocks* now in fourth edition (John Wiley, New York, 1930), which is unsurpassed as a laboratory manual, particularly for the meticulous care with which details of procedure are outlined. Dr. Groves' book, under

review, is a welcome addition to the literature in this field. The author claims in the Preface that he has kept in mind the needs of the chemist and the petrologist. Considering the limitation imposed by the size of the book, the author has, in some measure, succeeded in this task. It is but natural that he should follow the general scheme of the excellent work of Washington's. The introductory chapters deal with laboratory equipment and apparatus, the preparation of the sample, the reagents necessary, the constituents to be determined and the common operations in analytical work. The procedure is given carefully and fully, with useful emphasis on points which call for special precautions. In the text, the analytical procedure is printed in heavy type and thus separated from general discussion which is in ordinary type. Special chapters are devoted to alternative methods under special circumstances, and for technological applications. A welcome feature of the work is, as pointed out by Prof. Holmes, a chapter on the geochemical distribution of the elements on which a great deal of information has accumulated during the last few years, particularly in European Continental literature. The data presented are up to date and well-documented. The book should prove useful to silicate analysts in general and rock analysts and petrologists in particular, especially as it supplements the information contained in Hillebrand's and Washington's treatises. The printing and get-up are excellent and the price is not excessive for a work of this type.

M. S. K.

Gases and Metals. By C. J. Smithells, D.Sc. (Chapmann and Hall, Ltd.), 1937. Pp. vii + 218. Price, 18*s*. net.

This book is a complete introduction to the study of gas-metal equilibria. It deals with an important subject for, as the author points out, the absorption of gases on metals is now known to be a critical factor in many catalytic processes and in the manufacture of electric lamps and thermionic valves. A knowledge of the principles underlying the diffusion and solution of gases in metals is essential in the control of many metallurgical operations.

This volume contains three chapters dealing respectively, with the phenomena of absorption, diffusion and solution as they occur in gas-metal systems. The chapters though each about 70 pages long, are not unwieldly, as they are logically subdivided. The results of research in all these fields are carefully and accurately described, numerous diagrams being included in the text.

Although the author has not attempted to deal with the practical applications of the work, he discusses this collection of fundamental principles and research data in a readily accessible form will be of great help in the understanding and solving of related industrial problems.

This book is exceedingly well written and can strongly be recommended to all interested in this subject, and indeed generally to physical chemists and physicists.

T. S. W.

An Introduction to the Scientific Study of the Soil. By Norman M. Comber. (Edward Arnold & Co., London), 1936. Price 7/6.

This book does credit to the author's intention as expressed in his preface to the third edition: "This book is essentially a communication from a teacher to students and is written to give the general agricultural and horticultural student a concise account of the science of the soil ..... No attempt is made to give a description of laboratory methods: the sole object has been the presentation of a general conception of soil constitution and phenomena." The whole field of soil science is covered in a short space and yet the book does not suffer by brevity; the facts are stated in clear and unambiguous terms. The chapter on Base exchange termed "Adsorptive properties" and that on "Soil water" make refreshing reading. The author has escaped the baneful influence of interpolating personal views on controversial topics to which many authors are subject and puts views as they are conceived by others and by himself. He gives no doctrinaire views in the chapter on Adsorptive properties — a field to the knowledge of which he has contributed in no small measure.

In keeping with the above one comes across warnings to the students as "It is customary as in dealing with many reactions, to speak as if the equilibrium between soil bases and solution bases was a static

equilibrium. The student will realise however, that the equilibrium must obviously be dynamic."

A valuable chapter is the one on "The Artificial Treatment of Soil" including "Randomised Block method" of field experimentation. One wishes that a chapter on soil mapping had been added with instructions for reading soil maps. To the list of books of reference given at the end, could usefully be included the German work "Handbuch der Bodenlehre".

It is an excellent book for study by all beginners and will help the Indian student — especially of agriculture and forestry — in understanding the complicated processes going on in the soil, a necessary implement for his profession.

N. G. C.

Introduction to Optics. By G. B. Deodhar. (Indian Press, Allahabad), 1936, Pp. 614.

After a brief historical Introduction, the author devotes the first five chapters to Geometrical Optics; Chapter VI contains a good elementary treatment of optical instruments. In Chapter VII an excellent account of the several methods of determining the velocity of light including the latest work of Michelson, is given. Before proceeding to the treatment of the phenomena of Interference, Diffraction and Polarisation of light in Chapters X, XI and XII, the author deals with the theories of light in the eighth chapter. Chapter XIV is mainly concerned with the description of the different spectral regions and in Chapter XV, dealing with the elementary theory of spectra, the reader is introduced to the Quantum Theory. The next chapter deals with some of the more recent discoveries like the Compton and the Raman Effects. The last three chapters successively deal with "Colour", "Photometry" and "the Ether".

We thus see that the subject-matter dealt with is fairly comprehensive as a preliminary course in Optics. A feature of this book is the inclusion of a number of photographic reproductions. The treatment of the subject is clear, simple and free from advanced mathematics. The usefulness of the work is further enhanced by the inclusion in the Appendicies important tables containing useful data.

We have no hesitation in recommending the book to University students who are in need of an introduction to the important subject of Optics.

B. V. R. Rao.

Bulletin of the Madras Government Museum. 1. Scyphomedusæ of Krusadai Island. By M. G. K. Menon. Vol. I, No. 2, Pt. 3 (1936), Pp. 9, Price As. 8. 2. Decapod Larvæ from the Madras Plankton. By M. K. Menon. Vol. III, No. 5 (1937), Pp. 55, Price Rs. 1–14–0.

The first publication is one of the series of reports on the Fauna of the Krusadai Island issued under the joint auspices of the Madras Museum and the Madras Fisheries Department. It deals with the collections of Scyphomedusæ made by Dr. F. H. Gravely and the officers of the Madras Fisheries Department. Nine species of eight genera are recorded. Owing to the paucity of the material, one of the forms has been provisionally assigned to the genus *Tamoya* F. Müller. Detailed notes are given about the various species, except for those already dealt with in detail in the author's earlier paper (1930) on the Scyphomedusæ of the Madras Coast in the same journal. The most interesting of the present collection is *Chrioplasmus quadrigatus* Hæckel originally described from Madras, but since recorded from the Philippines.

The second publication forms a continuation of an earlier report (1933) in which the author described the larvæ of four species of Decapods of the Madras Coast. In the present paper, the author deals with a large number of forms of the two suborders, Natantia and Reptantia. Detailed descriptions of the various structures of the different stages of the larvæ of the Decapods dealt with in the report are given and the account is accompanied by very good illustrations of the whole larvæ and the various structures. The various forms dealt with have been identified generically and in some cases even specifically, but as most forms were not reared to the adult stage, the identifications in some cases are provisional. It is to be hoped that the author will be able to carry on his work further.

Drilling Mud.

IT is not always realised that problems relating to even apparently minor technical details of an industry often necessitate prolonged scientific research for their satisfactory solution, and that investigations which at first appear to be of quite an academic nature often lead up to results of great industrial importance. Both these aspects of scientific enquiry are strikingly brought out in a paper on "Drilling Mud: Its Manufacture and Testing" recently published* by Messrs. P. Evans and A. Reid of the Burma Oil Company. It is well known that in present day oil-field development, mud-fluid plays a very important part, and that unsuitable mud is the cause of many drilling troubles and of much loss in production. Though it is true that 'drilling mud' is essentially nothing more than a mixture of clay or shale with water, yet it has been increasingly realised within recent years that in actual practice, it is not always easy to get the right type of mud-water mixture to work with in drilling operations. Quite a large number of investigations bearing on the problem of the manufacture and testing of drilling muds have been made recently by the scientific and technical staff of the Burma Oil Co., and the present paper gives an admirable account embodying the main results of these investigations. In the course of the first 35 pages forming Part I of the paper, the authors deal with the manufacture of drilling mud; and in Part II which runs into nearly 250 pages, a detailed account is given of the testing of drilling mud with reference to its physical properties such as specific gravity, viscosity, thixotropy, surface tension, stability, etc., based on an enormous amount of experimental work carried out by the authors and their colleagues.

It is well known that there are three drilling systems in use in the oil industry: (*a*) percussion or cable-tool drilling, (*b*) core-drilling and (*c*) rotary drilling. Of these, the rotary drill, of comparatively recent development, is by far the most important, enabling the prospector to reach depths of ten to twelve thousand feet in his search for oil; and the use of a mixture of clay and water—termed 'mud-fluid' or 'drilling mud'—as a circulating fluid in rotary drilling is now a universally accepted practice. Seeing that in a single rotary well, as much as £ 25,000 are sometimes spent on the provision of this drilling mud, it is obvious that the properties determining the efficiency of this mud-fluid deserve the most careful consideration.

Drilling mud is usually made in a central plant for distribution to a number of wells, and the actual methods of manufacture are based either on churning, or jetting or preferably a combination of these. The mud plant must also deal with the problem of the reclamation of used mud, especially so where the cost of fresh mud is high. To obtain the best results, in both manufacture and use, adequate testing is required, and this subject has been discussed at great length in the paper. According to the authors, perhaps the most important test on a mud, and the one least understood, is the measurement of viscosity. The paper describes the various kinds of viscometers used for measurements on mud-fluids, and discusses their relative merits. A very valuable contribution of the authors in this study is their recognition of the fact that a full expression of the viscosity of a drilling mud must take into consideration two factors—'yield value' and 'mobility'. Drilling mud in flow does not behave in the same fashion as a simple liquid, such as water or oil; whereas the smallest force applied to a true liquid in a long narrow tube will cause a slow flow, this is not so with drilling mud, which possesses a 'yield value' which must be overcome before flow takes place. The resistance to flow depends not only on this initial resistance, but also on the 'mobility' of the mud. Thus arises the necessity for describing the viscosity of mud-fluids in terms of both these factors. The nature of this type of flow which the authors propose to call 'plastic flow' has been discussed at great length in view of its importance in the study of drilling muds. The problem of the flow of mud in the circulating system of a well, which has received but little attention so far, has also been tackled and many useful suggestions have been made regarding the possible correlation of the physical properties of the mud with the pressures needed

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* "Drilling Mud: its Manufacture and Testing" by P. Evans, B.A., F.G.S., M.Inst.P.T., and A. Reid, M.A., B.Sc., A.M.Inst.P.T.—*Transactions of the Mining and Geological Institute of India, Calcutta*, Vol. XXXII, December 1936. Price Rs. 12.

in the pumps to force the mud through the circulating system. In addition to a full treatment of these important considerations, the paper also deals with various other aspects of the testing of drilling mud and draws pointed attention to the lines on which further experimental investigation and research are necessary.

The paper is profusely illustrated with photographs, diagrams and sketches; and the graphical presentation of experimental results which the authors have frequently adopted is indeed very effective. The subject-matter has been presented in a very clear and lucid manner and the treatment is throughout thoroughly practical, with numerous references drawn from a wide range, including the authors' own experiences in this field of work. The paper is thus a most valuable and authoritative contribution to the study of an important aspect of present-day oil field development.

L. RAMA RAO.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
University Librarian, Madras

Morton Richard (1637–1698)

RICHARD MORTON, a British Physician of repute, was born on 30th July 1637. He matriculated in 1654, graduated from the New College, Oxford, in 1657 and became an M.A. in 1659. Having been a minister and ejected from his living in 1662 on account of his refusal to comply with the requirements of the Act of Uniformity, he turned his attention to Medicine, became an M.D. in 1670 and afterwards settled in London.

His Career

He became a Fellow of the College of Physicians in 1679. James II omitted his name from the charter granted to the College in 1686, but he was restored to his position in 1689. He was censor for several years and eventually became a physician in ordinary to the king.

His Contributions

Morton was recognised to be one of the principal nosographers of the seventeenth century. He popularised the use of cinchona. There was keen rivalry between him and Sydenham. He published two important medical works: *Phthisiologia* (1689) and *Pyretologia* (1692).

The first of these is regarded as a treatise of the highest value. Morton uses the words Phthisis in a very wide sense, to denote not only wasting due to tubercle in the lungs but also the wasting effects of jaundice, gout and other ailments. His second book was one of the first books to recognise scarlet fever as a distinct disease. Morton's works were included in the *Opera medica* which was first published at Geneva in 1696 and went through several editions for nearly half a century.

Morton is said to have been "a man of great gravity, calmness, sound principles, of no faction, an excellent preacher, of an upright life."

He died in London on 30th August, 1698.

Giffen Robert (1837–1910)

SIR ROBERT GIFFEN, a British Statistician, was born at Strathaven, Lanarkshire on 22nd July 1837. His father was a petty merchant. He attended the village school and was in charge of the Sunday-school Library. This opportunity was fully utilised by him. He read all the books he could find and wrote articles and poems for a newspaper.

His Career

After having been in the legal profession for about ten years, he adopted journalism in 1860. He served for a time with John Morley on the staff of the *Fortnightly review* and later became an assistant editor of the *Economist* under Walter Bagehot. He was also the City editor for many newspapers and one of the founders of the *Statist*. In his classical *Report on local taxation* (1871), Goschen acknowledged his indebtedness to Giffen and in 1876 Giffen was appointed to the Board of Trade as the head of the Statistical Department and was later elevated to the position of Assistant Secretary and Controller. He retired from the latter position in 1897.

His Contributions

He was a prolific writer on financial and statistical subjects. His instructive handling of statistics and his keen eye for pitfalls contributed greatly to raise the reputation and encourage the study of statistics in Great Britain. Besides several articles

in learned periodicals, he had published eight books. The *Handbook of Statistics* was ready for publication at the time of his death. His presidential address on *The importance of general statistical ideas* to the section of economics and statistics of the British Association for the Advancement of Science in 1901 broke new ground. He was also a founder of the International Statistical Institute in London (1885).

HIS HONOURS

Glasgow University conferred on Giffen an honorary LL.D. in 1884. He was created C.B. in 1891 and K.C.B. in 1895. He was also a Fellow of the Royal Society. His services were required on various commissions and committees and his work on the Royal Commission on the Depression of Agriculture in Great Britain in 1893–1897, was greatly appreciated.

In a minute written after the passing of the Bankruptcy Act of 1882, Joseph Chamberlain described Giffen as "to a great extent the real author of the measure, to whose exhaustive memorandum on the subject, I owe the best part of my own knowledge".

The following estimate of his statistical ability may be of interest. "He had an arithmetical sense almost amounting to genius, a feeling for the probable errors of the factors used, and a courageous rejection of measurements where the inaccuracy was too great. He had an intuitive feeling for the relative importance of numbers."

While on a visit to Scotland, he suddenly died of heart-failure on April 12, 1910. He had no children.

Worth, Richard Nicholas (1837–1896)

R. N. WORTH, an amateur geologist, was born on 19th July 1837 in Devonport. He was apprenticed at the Devonport and Plymouth *Telegraph* and became a member of its staff in 1858. Throughout his life he pursued the career of a journalist.

HIS CONTRIBUTIONS

But Worth devoted all his spare time to investigating the history and geology of the West of England. Patient and exact, dreading hasty theorising, he did not a little for the archæology and geology of Devon and Cornwall. In the last thirty years of his life, Worth had 140 of his papers published, his geological papers having appeared in the *Quarterly Journal* of the Geological Society of London. He was a fellow of the same Society and twice president of the Plymouth Association and once of the Devonshire Association for the Advancement of Science, Literature and Art.

Worth died suddenly at Shaugh Prior on July 3, 1896.

ASTRONOMICAL NOTES.

Planets during August, 1937.—Mercury will attain greatest elongation 27°E. on August 18 and will be visible for a few days about this date in the western sky soon after sunset. Venus will continue to be a morning star throughout the month; on August 3, it will be in conjunction with the Moon, the planet being about a degree south at the time. Mars is moving eastwards in the Constellation Scorpio and will be crossing the meridian at about sunset. There will be a close approach with Antares (α Scorpii) on August 26, the planet (Stellar magnitude, 0·1) passing about 2° north of the star; on August 15, Mars will be in close conjunction with the Moon.

Jupiter will be a conspicuous object in the eastern sky at about sunset reaching the meridian at about 10 p.m. Saturn is in the constellation Pisces and slowly moving westwards. It rises about 9 p.m. in the middle of the month. The Ring ellipse has major axis 43″ and minor axis 4″. Uranus can be seen close to the star σ Arietis (magnitude 5·5) which is nearly equal to it in brightness. The minor planet Ceres will be in opposition on August 21, but its magnitude at the time will be 7·8 and the object will be visible only with some simple optical aid.

Of the comets reported this year, only Whipple's Comet is still fairly bright and accessible to instruments of moderate aperture.

Comet 1925 II (Schwassmann-Wachmann), a periodic comet, was found on May 6 by Van Biesbroeck on plates taken at the Yerkes Observatory. It was a very faint object of magnitude 15·5. The comet has a slightly eccentric orbit situated between the orbits of Jupiter and Saturn. As during previous oppositions, Van Biesbroeck notes striking fluctuations in the brightness of this Comet.

Among interesting phenomena occurring in August, mention has to be made of the Perseid meteoric showers August 10–12; the position of the radiant point is R.A. 3^h 0^m Declination 57°N.

Important Insect Pests of Sugarcane in the Bombay Presidency.

By V. G. Deshpande,
Agricultural College, Poona.

SUGARCANE is one of the most important crops of this Presidency. According to the recently published statistics, the area under this crop in this Presidency (including the states) is about one lakh of acres. As a result of the protection in the form of tariff, the area is fast increasing and there are indications that the cultivation of the cane crop will extend very considerably and the problems connected with this industry are sure to assume more and more prominence in future. Of the different problems, the one connected with the insect pests is no less important and it is certainly desirable that the sugarcane farmer should know how to save his crop, as far as possible, from the ravages of insects. So far as the present knowledge about the control of insect pests in general goes, all advice is embodied in two sentences : (1) " Prevention is better than cure " and (2) " Catch and kill ". However, common-sense methods of control based on the habits of the pests are also useful and it is with this intention that this article is written, giving all the available information about the major insect pests of sugarcane, along with the control measures, which have been tried and found useful.

Thanks are due to Dr. K. R. Karandikar, Ph.D., for going through the manuscript and making some useful suggestions.

The following is the list of the important insect pests found on sugarcane in this Presidency :—

Serial No.	Common name	Scientific name	Nature of damage	Status
1	Grasshopper	*Hieroglyphus banian* Fb. Var. *elongata*	Leaf eating	Occasionally major
2	Mealy bug or Scale insect	*Trionymus sacchari* Ckll.	Leaf and stem sucking	Minor
3	Mealy wing or white fly	*Aleurolobus barodensis* Mskll.	"	"
4	Leaf hopper	*Pyrilla aberrans* Kirby	"	"
5	White-ants	*Termites* sp.	Roots	Occasionally major
6	Cockchafer grubs	*Phyllognathus dionysius*	"	"
7	Root-boring caterpillar	*Emmalocera depressella* Swinh.	"	Minor
8	Stem-borers	(i) *Chilo zonellus* Swinh. (ii) *Argyria sticticraspis* Hmp. (iii) *Procometis trochala*	Stem boring	Very minor & rare Major Minor

From the point of damage the stem-borers are the most destructive. Next in rank may come the grasshoppers and the cockchafer grubs. Mealy bugs and other insects will occupy the last place. As regards the white-ants they are polyphagous and as such should not be considered as a specific pest of the sugarcane.

The Sugarcane Grasshopper.

Of the pests feeding on the leaves of this crop, the grasshoppers should be considered as the most important. Since last 10 years not a year has passed without receiving any report from the cultivators, on the attack of this pest. The species found in the sugarcane area is not the typical *Hieroglyphus banian* which is usually found attacking the paddy crop, but it is a variety of the same species known as ' *elongata* ' (Uvarov, 1922). This grasshopper resembles the " Rice grasshopper " to a great extent, but is larger in size. From the eggs laid in the waste lands, in the previous season, the nymphs hatch out after the first showers of the monsoon, *i.e.*, by the beginning of June. These nymphs spread about in the adjoining cane crop and remain active feeding on leaves. The growth is complete by the end of September and from October onwards their activity diminishes. The height of damage is reached in the months of August and September and in bad cases of attack all the plants are almost stripped of leaves leaving only the midribs. So far as this Presidency is concerned the ' *elongata* ' variety appears to be confined to the sugarcane area under the Pravara Canals (Ahmednagar District) and also attacks rice in Belgaum.

The usual method of controlling grasshoppers is by bagging. This is a useful method in the

very early stage and when the crop is small; but this is out of question in the sugarcane crop in July, when the crop is about five or six months old and too tall for bags to be worked and much less afterwards. Poison baiting was tried, but it was not effective for two reasons. Firstly, there was the difficulty of keeping the baits in proper places and secondly the bait did not attract the grasshoppers. At the end of December these adult grasshoppers might be migrating to the fallow and waste lands round about the cane area, since none of those grasshoppers have been observed in the fields. It is in these waste, fallow and unploughed lands that the egg-laying is done and the infection starts in the next season from these waste lands. Therefore, the following control measures are suggested :—

(1) Plough in summer every year all the waste and fallow lands round about the affected field to expose and destroy the egg masses.

(2) Bagging should be done immediately after the nymphs hatch out in the open fields and before they migrate to the cane crop.

The Sugarcane Mealy Bug.

The mealy bug found on sugarcane belongs to the species *Trionymus sacchari* (known formerly as *Pseudococcus sacchari*). It is pinkish-white in colour and is covered with a powdery white meal. These bugs always remain hidden under the sheathing leaves. Small pinkish eggs are found under the body of the female covered with a white mealy mass. Young ones after hatching find out suitable places for feeding purposes. Owing to the attack of this pest, the crop becomes stunted and looks unhealthy. The infestation spreads from field to field by means of setts taken for planting from the affected fields. The quality and quantity of *gul* are affected. In the year 1920–21 on the Manjri Experimental Farm (now abolished) and in 1921–22, on the Belapur Company, the sugarcane crop was very badly infested by these bugs. The following methods of control then used were found to be useful and efficacious :—

(1) All the cane setts at the time of planting were dipped in a strong solution of Fish Oil Rosin soap (2%).

(2) All the trash and rubbish were collected and burnt after harvest.

(3) Ratooning was stopped.

The Sugarcane White Fly.

This is a minor pest. Wherever this pest is present the leaves of the crop especially the undersides are covered with black specks. These are the young stages of the adult insect which possesses two pairs of wings. The adults die away after laying the eggs on top shoots. The nymphs that hatch out stick on at suitable places, feed on the sap and grow. The grown-up nymphs are covered with a waxy meal. The attacked crop looks unhealthy. The only control measures that may be used are :—

(1) Destroy all affected leaves as soon as the pest is noticed.

(2) As far as possible the old cane should be harvested before new planting is done, taking care to destroy all the trash from the fields where the pest is present.

The Sugarcane Leaf Hopper.

The species found prevalent in this Presidency is *Pyrilla aberrans*. As a rule, this is a minor pest, occasionally becoming abundant in certain localities. This leaf hopper is a small bug with prolonged head and yellowish brown anterior wings. It lays eggs in masses on the underside of leaves, covered with a white waxy material. The nymphs are peculiar creatures and can at once be recognised by a pair of fluffy processes at the end of the abdomen. The nymphs and adults, both suck the juice. The insect is very active from August to December.

Control measures :—

(1) Collect and destroy the egg masses.

(2) Destroy all the trash after harvest.

(3) Do not take a ratoon crop.

Termites (White-ants).

Great amount of damage to sugarcane is done by white-ants. The damage is done by feeding at the roots and causing the death of the setts. This pest is very active a short time after ploughing, *i.e.*, from April to June. Owing to the death of some plants a patchy appearance of the field is noticed. The best control is afforded by the application of Crude Oil Emulsion in the irrigation water to the affected plots.

Cockchafer Grubs.

This is a very serious pest and has been reported from all over the Presidency. These grubs are found under the soil and feed on the roots. Consequently, the damaged clumps wither and die. The damage is very serious from July to October. It is not exactly known as to how many species are involved. The species that was reared in 1920–21 from the grubs sent from Satara was *Phyllognathus dionysius*. It has been observed that those fields which receive ill-rotted manure are generally more affected.

A large number of remedial measures has been advised in different books such as the use of Gypsum and Naphthalene, but none of them seem to be practicable and economic.

Hardly any control measures are therefore possible at the time when the crop has been sufficiently tall, however the following preventive measures may be tried :—

(1) Do not give an ill-rotted farmyard manure to the sugarcane fields.

(2) Plough the fields after harvest to expose the grubs.

The Root-Borer.

This is very rarely observed in this Presidency except in some localities where ratooning is practised. The damage is done under ground and ordinarily ascribed to white-ants. In 1921–22 this pest was noticed on the Belapur Company, in the old canes. The caterpillar is pale yellow in colour with a brown head. It bores into the young seedling and tunnels down towards the root causing the death of the whole clump. It is active from April to June. The only control measure that can be advised is that no ratooning should be done where the pest is prevalent.

Stem-Borers.

Of all the pests, the stem-boring caterpillars are the most destructive. Isaac and Misra (1933) mention that "there are five species of stem-boring caterpillars known and of these the following three are the most important:—

(1) *Argyria stricticraspis.*

(2) *Chilo zonellus.*

(3) *Diatræa venosata.*

Of these three the first two are more important than the third. Ramkrishna Ayyar and Margabandhu (1933) state that *Argyria sticticraspis* is the principal pest in Madras and add " What is *Diatræa sacchari* to the sugarcane countries like Louisiana, British Guiana, &c., *Argyria sticticraspis* is to us." So far as this Presidency is concerned *Argyria sticticraspis* and *Procometis trochala* are found attacking the stems.

1. *Argyria sticticraspis.*—Of these two borers the first one is the most important and widely found. The species *Chilo zonellus* has rarely been found on sugarcane in the Deccan tract (Ramrao, 1920). The facts known about the *Argyria* caterpillar as mentioned in the Bulletin "The Sugarcane Borer and its Control" (Ramrao, 1920) are as follows:—

" (1) The pest hibernates as a larva during the cold of winter in cane shoots, which it attacks before the setting in of cold winter.

(2) The generations overlap considerably as even among the hibernating larvæ we usually find young and old caterpillars.

(3) The larvæ continue to attack young cane shoots all through the year except during the cold winter months. Such young shoots are almost always found in cane fields. The pest therefore gets ample opportunities to breed as the cane occupies the field during the whole year.

The loss to the sugarcane grower is not restricted to the death of germinating cane where the loss is often as high as thirty to forty per cent., but the crop tends to show a bushy growth resulting in thin canes which do not ripen at the same time as the rest. The yield is less in juice and the cane gets a check at the start which it cannot easily make up."

Control measures:—

(1) The cane should be planted as early as possible. The first week of January will suit the conditions of sugarcane cultivation in this Presidency.

(2) After the harvest the stubbles should be dug out and the roots exposed to the sun to prevent any tillering of the stubbles.

(3) Ratooning is not advisable.

The first recommendation of " early planting " is based on the fact that the cane plants should be at least three months old, if they have to escape being attacked by the borer which becomes active by the middle of March in the Deccan. This recommendation is being followed largely by the sugarcane growers in this Presidency and the following figures received from one of the sugarcane farms (Gokak—Dist. Belgaum) will illustrate the relation between early planting and the incidence of the borer attack:—

Date of planting	No. of rows	No. of total canes	No. of affected canes	Percentage of borer attack
15–2–33 ..	9	147	0	0
1–3–33 ..	7	117	10	8·5
15–3–33 ..	9	181	20	11·0
1–4–33 ..	9	167	55	32·9
15–4–33 ..	9	461	180	39·0

2. *Procometis trochala* Myer.—When the sugarcane on the Manjri Experimental Farm was being harvested in the month of February 1924, a large number of canes was observed being bored by caterpillars which were reported to be *Argyria* sp. On examination these borers were found to be quite different. The moths reared from them were got identified as *Procometis trochala* from Pusa.

This borer has been observed by the writer for the first time in 1924 attacking the sugarcane. The caterpillar is dirty white with a reddish tinge, head reddish brown; when full grown it measures 1¼". It has the habit of feeding into the pith by making large galleries, throws out a large amount of frass and feeds from inside the pellet of excreta. The whole cane in damaged. More than one caterpillar are found inside one cane.

Considering the amount of damage this is a minor pest and needs no control measures.

1. " Annual Report of the Imperial Entomologist," 1917–18.

2. Isaac, P. V., and Misra, C. S., *Agric. and Live-Stock*, 1933, **3**, Part IV.

3. Ramkrishna Ayyar, *Madras Agric. J.*, 1935, **21**, 421.

4. Ramkrishna Ayyar and Margabandu, *Agric. and Live-Stock*, 1935, **5**, Part V.

5. Ramrao, S. K., *Bull. Dept. Agric., Bombay*, 1920, No. 94.

6. Uvarav, B. P., *Bull. of Ent. Res.*, 1922–23, **13**.

Agricultural Research in China.

By Robindra Mohan Datta, *Calcutta.*

CHINA is a very big country with an area of 1,532,815 sq. m. and a population of 430 millions. Like India, the country is mainly agricultural and 80 per cent. of its population is directly dependent upon it. After it came into the hands of the Republican Government, the authorities are trying hard to put the National agriculture on a sound and scientific basis.

Since the rural depression in China (1931–32) a scientific study of the various branches of agricultural science is being conducted at several centres in China. Existing agricultural conditions are closely followed by a Crop Reporting Service and students of Farm Economics. Researches are also conducted on Land management to give the farmers the best returns by helping them to market their products. Plant pathology and entomology are studied side by side for the improvement of all crops and careful experiments are carried out on soils and fertilisers. Sericulture and animal husbandry are emphasised as important rural industries.

Rural credit and co-operative societies have been organised and developed. A net work of Government warehouses have been erected in the chief agricultural centres for the storage of farm products; their transportation is thereby facilitated.

At present, the work in agronomy is chiefly confined to crop improvement in regard to wheat, rice, cotton and potatoes. Attempts are being made to extend the work to other less important crops.

There are nine co-operative stations under the Wheat Improvement Project, sixteen under the Cotton Improvement Project and five under the Rice Improvement Project. The National Agricultural Research Bureau, at Shadingwei, Nanking, inaugurated in December 1931, is co-ordinating the work of these stations.

Research in Wheat.

The investigations are directed to—(1) study of important indigenous varieties, (2) collection of world wheats and (3) the improvement of wheat through selection and hybridisation.

The important wheat varieties in China are studied through large regional surveys. A number of stations are engaged in this work. The purpose of the survey is to find out the varieties the Chinese farmers are growing and the environmental conditions suitable for their cultivation. These studies have shown that certain varieties grown in the South will not do well when grown in the North or Central China and the same has been found to be true of the Northern varieties when planted in the South. The results of this research have made it possible to determine the zones, adapted for different varieties.

A number of American varieties of wheat have recently been introduced and field trials are being conducted to determine useful varieties. The results so far obtained show that while some of them yield fairly good results, they cannot be harvested early enough to fit into the rotation system practised by the Chinese farmer. Researches on breeding by selection is being conducted and a large number of wheat selections has been made, which are being compared with standard types. Tests are also being carried out in the various zones to determine their environmental adaptability.

Hybridisation work has been begun by crossing different varieties paying special attention to such problems as earliness, disease-resistance, (resistant to stinking smut, *Tilletia tritici* and loose smut, *Ustilago tritici*), shattering, stiffness of straw and the like.

Because of adverse weather conditions it is sometimes impossible for farmers in China to sow their wheat at the proper time. Furthermore winter-killing is a very serious problem in the North. The possibility of vernalisation is being examined to meet the problem. The process consists of germinating the seeds and keeping them chilled until sown. The results of the first year showed that the seed thus treated (planted on March 31) headed 4½ months earlier than seeds of the same varieties planted the preceding autumn without treatment. The varieties planted on March 31 without treatment did not head at all.

Experiments are also being conducted to study the method and time of planting on the yield of three common varieties of wheat grown in Nanking, paying special attention to the rate of germination, the number of tillers and the rate of growth of different varieties.

Researches on Rice.

Regarding the rice improvement work researches were started in 1933, when technical experts were sent to Kiangsu, Chekiang, Anhwei, Kiangsi, Hupeh and Hunan Provinces to make a large number of selections from the fields. The rice work includes improvement through selection and hybridisation, varietal tests and study of factors influencing yield.

During the year 1934, the selections made in the previous year were sown (a total of 49 thousand rows were sown). Each row represented an individual head collected from a farmer's field. By continuing to select the best ones each year for planting in the following year, it is expected that new strains which will be better in yield and possibly in some other characters such as disease-resistance will be discovered.

The varietal trials consist in comparing under uniform conditions, a large number of varieties collected from different parts of China as well as from Japan, Philippines and the United States of America.

Regional tests are also being conducted at a number of stations to determine the soil and climatic factors suitable for different varieties. Researches in the hybridisation of the Chinese with foreign varieties of rice are being conducted and promising results have been obtained.

The study of the influence of period of illumination on flowering has shown that the length of day has a profound influence on the different varieties of rice. A shortening-day treatment will make the early, medium and late varieties to flower at the same time thus rendering intercrossing of these varieties possible. Similarly,

this treatment can be used to cross tropical varieties with the Northern varieties.

A comparative study of the different field layouts is being made to find out which of the three kinds of arrangements is being best for experimental work, *viz.*, the "advanced test", the "Latin square" and "randomized blocks". A difference of opinion exists among agronomists as to the best field arrangement for rice experiments.

Work on Other Crops.

In the Cotton Improvement Project extensive regional tests have been made since 1933 by obtaining a large collection of Chinese and foreign varieties of cotton and testing them in a number of experimental stations.

Technical experts have been sent to seven cotton-growing provinces to select bolls from promising plants in the farmers' fields. More than thirteen thousand individual bolls have been selected. After a laboratory examination the poorer ones are discarded and the better ones preserved for planting. Varietal tests and work in hybridisation are also conducted in connection with cotton improvement.

Five improved varieties of Irish potatoes and nine improved varieties of sweet potatoes have been made available to the Chinese farmers. Experiments in hill selection, the length of row, shape and size of plot, are made in this connection.

Diseases and Pests.

Intensive work in plant pathology and entomology was begun in 1933. Investigations are being conducted on rice borers, locusts, insect attack of stored grains, fruits and vegetables. Rice borers have been causing serious damage in China. The problem of locusts is receiving considerable attention. The damage done by the locusts to crops in 1933 is estimated at $ 14,000,000.

A survey of the plant diseases prevalent in China is being made. Technical experts have been sent to study the diseases of field crops, vegetables, horticultural crops and the mulberry trees. The study of wheat smuts has assumed importance as the loss due to smuts has become enormous. Hot-water treatment has proved satisfactory in controlling the disease. The treatment is specially preferred as it involves little expense and obviates the use of chemicals. Diseases of summer crops, such as the downy mildew and the helminthosporiose of cereals and the leaf spot of the pea-nut are also being studied.

Other Investigations.

A study of farmyard as well as chemical fertilisers is being made in order to determine the type and combination of fertilisers most beneficial and economic under Chinese conditions.

A large number of researches bearing on Forestry are also being conducted in recent years. Studies on germination and storage of seeds are being systematically conducted and a searching enquiry is being made into the sylvicultural methods. Seeds and seedlings of improved varieties of forest trees are distributed.

In order to develop better varieties of the silk worms a large collection of eggs has been made from different parts of the country as well as from abroad. So far 12 varieties giving high yield of silk per cocoon has been selected. In determining the quality, other features such as the shell weight, tensile strength, elasticity, evenness of fibre and the percentage of silk obtained, have to be taken into consideration and these aspects are receiving attention. The diseases of the silk worms are also being studied. Thus copper sulphate and bleaching powder can be effectively employed in the control and eradication of certain diseases including muscardine, a serious disease of the silk worm.

The Department of Crop Reporting of the National Agricultural Research Bureau is engaged in the collection of statistics relating to the acreage and production of crops. The data collected is made available to the public. There are more than six thousand voluntary crop reporters among the twenty-two provinces of China.

The trend of farm prices of agricultural products are also studied. Problems pertaining to livestock, land tax, land value, rural credit, rural population and food consumption are investigated in order to ascertain the economic status of Chinese farmers. The marketing of agricultural products is also studied along with the economic conditions. The study of Farm Economics is very important as one of the causes of the last rural depression was the ignorance of the conditions of marketing as well as to the absence of transport facilities. In some centres large quantities of grains accumulated and in others there was total lack of grains.

Veterinary science has received the attention in connection with animal husbandry. Various kinds of sera and vaccines for the control of diseases are being developed.

Besides technical work for improvement of agriculture, a system of rural credit has been organised to relieve the impoverished farm population. The National Economic Council and the Ministry of Industry are co-operating with the banks and the provincial and the district government authorities in this work. The farmers are assisted to form co-operative societies by the Government who direct the organisation. Every village is to have one such society and a group of villages is to form a union of co-operative societies. In a *hsien* (something like our Union Board) there is to be a local rural co-operative bank which is linked with the provincial rural co-operative bank and then to the Central Government Co-operative Bank. The Government finances such co-operative banks whose primary function is to advance loans to village co-operative societies and co-operative unions. They also absorb deposits and transact ordinary banking business such as transfers and remittances.

Another scheme to help the Chinese farmers is the construction of a network of warehouses. These are of four kinds:—(1) the warehouse in the producing centre, (2) the warehouse for goods transmit, (3) the warehouse at the destination or the market, and (4) the warehouse for storing. The warehouses in the producing centre are equipped with packing machinery and occupy an area just large enough to allow temporary storage of the grains only. The warehouse for goods in transit is of a still more temporary nature.

My sincere thanks to Dr. Chen Chang Loc, Ph.D., LL.D. (Chic.), the Consulate-General for the Republic of China, Calcutta, for kindly permitting me to use his personal library.

Research in Animal Husbandry in India.

THE *Proceedings* of the Animal Research Workers' Conference held in New Delhi in February of the year 1936, which has just been issued is a publication of great interest and brings together the results of research work now in progress in the different provinces in connection with animal diseases, animal nutrition and cattle-breeding. Animal Husbandry in India including Veterinary medicine has long suffered from the lack of appropriate provision for research work and one is certainly gratified to find evidence now of a great and welcome change taking place. The *Proceedings* bear ample testimony to the change that has thus come over, and the papers read and the discussions thereon cover a very wide ground indeed, numbering twenty different subjects in all. To some of these we make a brief reference below.

In the important and at the same time very difficult matter of the establishment and maintenance of pedigree herd-books in India, Bombay is reported to have made a good beginning, the details being explained by the Live-Stock Expert of Bombay. Its success and popularity is shown by the fact that such pedigree cattle fetched from 15 to 20 per cent. more than the unregistered ones in the weekly sales. Only some 2,100 animals have so far been registered and we should have appreciated it if the cost incurred had been given, so that some idea of what the cost of introducing it over large areas may be obtained. Intestinal parasites in sheep and cattle which cause a great deal of havoc in many parts of India, forms the subject of another paper together with the methods of combating the pest. Copper sulphate and Kamala have been found the most efficient remedies and they are recommended for a wider trial. Mineral deficiencies and the diseases due to that cause have been further investigated and the improvement resulting from the addition of half a pound of sterilised bone-meal to the ration is reported to have been striking. The account of the work of the Cattle Farm in Hissar on the improvement of fodder supplies by various methods is of much interest as well as the points elicited in the discussion relating to the increase due to manuring with superphosphates and the use of molasses in the making of silage. Apparently no work has been done on the new A.I.V. process of silage-making. The subject of inoculation against rinderpest in which results of outstanding practical importance have been achieved comes in for further discussion. An interesting contribution is the reference made to the use of dried vaccine now being experimented with in Burma. The discussions bring out considerable differences of opinion about the merits of the different methods in use at present, both in regard to their immunity value and their suitability to oxen and buffaloes alike, which only shows the need for further research even in a subject on which one was encouraged to believe there was comparative certainty. Animal Nutrition Research in Coimbatore deals with many fundamental points on some of which conclusions different from accepted ones have been arrived at. The protein requirements of working animals, mineral metobolism of young and dairy stock, and the effect of manures on the composition of the grain, especially in the protein make-up, are all of great interest and it is a pity that the author could not attend the Conference and the papers could not therefore be discussed. Bovine tuberculosis is the subject of another paper and the discussions have centred round the selection of an efficient diagnostic agent. Doyle's disease of fowls, bovine surra, congenital blindness in calves, canine diseases, hump sore, and Johne's disease, are other matters of veterinary interest discussed.

The experience of the Mysore State in the breeding of sheep for wool, chiefly through cross-breeding with imported Merino stock, forms interesting reading together with the report on this work by the Technical Adviser on Wool, Mr. J. Addyman, who inspected the flocks. Blow-fly attack which, it was emphatically stated, was a limiting factor in sheep improvement elsewhere was reported to be non-existent in Mysore. The experiment appears to us to be eminently deserving of being taken up by the Imperial Council of Agricultural Research for being worked as a major subject. The improvement of goats is another important subject discussed. Seeing that the goat is an exceedingly hardy animal, and is both a milk and a meat animal, differing in this latter respect from the cow (at any rate as far as the Hindu population is concerned) one would really like to see an adequately large scheme of improvement launched. We note that no mention at all was made of Angora goats in this connection. In the subject of dairying the Imperial Dairy Expert brings together an elaborate list of problems for research on various aspects of the dairy industry in this country; it strikes us however that even with our present knowledge a good deal more could be done for the milk supply of cities than is the case at present. The Pusa method of pre-milking and udder massaging with the resulting improvement is described in another paper, though the discussions revealed neither enthusiasm nor support for the methods. Having had occasion however to see these animals in their new home in Delhi, one must say the experiment is promising and deserves to be given a wider trial.

The *Proceedings* comprise a very commendable record of work both in volume and variety and what gratifies us more is the policy of "full steam ahead" which unless we are much mistaken, is discernible in its pages.

SCIENCE NOTES.

Edward Bausch.—The *Journal of Applied Physics* for May 1937 contains a biography of Edward Bausch of the well-known Optical Firm, Messrs. Bausch and Lomb of America. We there learn that Bausch was born at Rochester, N.Y., on September 26, 1854, and was introduced to the optical industry in his very childhood by his father who himself had been trained in the famous optical shops of Germany. Bausch showed his aptitude by constructing a microscope when he was fourteen. At first their business, started in 1853, had to be confined to the manufacture of spectacle lenses and its first success came with the introduction of vulcanised rubber frames. Bausch entered the Cornell University in 1871; in 1874 he returned to the firm and began the manufacture of microscopes. Experience gained at the Philadelphia Centennial Exposition of 1876 led him to introduce power-driven machinery into the business. When in 1878 the American Microscopical Society was founded, Bausch became a charter member. Improvements introduced by him into microscope design were the incandescent lamp in place of the mirror, a prism for the microscope tube for binocular work and the invertible microscope. He was also the inventor of an improved microtome and of the iris diaphragm shutter of the between-the-lens type. Visiting the well-known optical manufactories of Europe in 1888, Bausch brought back Dr. Hermann Kellner with him and started a scientific bureau under his direction. Devising machinery for the mass production of microscopes, Bausch brought the instrument within the reach of students of moderate means. The Company began the manufacture of chemicals in 1893 but with the development of the business it was handed over to the Will Corporation of Rochester. The firm of Bausch and Lomb rendered signal service to the U.S. Government by the manufacture of search light mirrors for the Navy, and by supplying optical glass during the Great War. The ever-increasing demand for optical glass was met cheerfully and without murmur and no obstacles were allowed to stand in the way of serving the country to the utmost limit. The Bausch and Lomb families are also associated with the founding and running of the Mechanics Institute of Rochester and of the Physics Building of the University of Rochester. We have pleasure in joining our contemporary in felicitating a man whose services have benefited not only his country but the cause of Science throughout the world.

* * *

A Clue to Early Man.—To fill the need for a research centre that would provide opportunity for bringing together all that is known of early man and stimulate work in this field, the Academy of Natural Sciences of Philadelphia, has established a separate department, and provided the necessary laboratories. Dr. Hellmut De Terra who recently visited India, and made important discoveries of evidence of pre-historic life in the regions of North West India is associated with Dr. Howard in organising the work. The organisation of the Academy's fossil collections which number some 200,000 will be supervised by Dr. Howell, Associate Professor of Geology and Palæontology at Princeton.

A symposium on Early Man was held at the Academy in March, last, in which scientists from China, South Africa and Europe took part. The symposium which synchronised with the celebration of the 125th Anniversary of the Founding of the Academy, provided a unique opportunity for scientists to meet and discuss problems of the ancestry of the human race.

* * *

Poisonous Gases in Industry.—The Department of Scientific and Industrial Research has recently issued the first of a series of leaflets describing standard methods for the detection of toxic gases in industry. The present leaflet (H. M. Stationery Office, 3*sh.* 6*d.*) deals with hydrogen sulphide (sulphuretted hydrogen). It is perhaps not generally realised that this gas is very poisonous in high concentrations. For example, in concentrations of one part in one thousand by volume of air it is nearly as poisonous as prussic acid and can kill almost as quickly. In concentrations of one part in 10,000 it gives symptoms of irritation in the eyes and throat after one hour's exposure. The gas has a very widespread occurrence in industry. "In addition to its formation during the decomposition of all organic matter containing sulphur, it is encountered in many important industries, among which may be mentioned: artificial silk works, chemical works, dye-making and dyeing works, coke oven and by-product plants, gas works, grease refining works, petroleum refining works, tar distillation works and sewage works. It is also encountered in the cleaning of sewers and cesspools connected with various other works."

"It is sometimes suggested" the leaflet continues "that the presence of dangerous concentrations of hydrogen sulphide may be detected by smell. It cannot be too strongly emphasised that reliance cannot be placed on the sense of smell as a guide to safety, because persons differ greatly in their ability to detect smells and furthermore the sense of smell readily becomes 'tired' and is of little value thereafter in noting even much increased concentrations. Again, the smell of hydrogen sulphide may be masked by other odours."

The method of test adopted depends on drawing a known volume of the atmosphere under test through a piece of test paper treated with lead acetate specially fitted to a hand pump. The test paper becomes stained a brownish colour and concentrations of hydrogen sulphide from 1 part in 150,000 upwards can be gauged by comparing the colour of the stain with a carefully printed colour chart attached to the leaflet. Full instructions for carrying out the test under standard conditions are given.

* * *

Atmospheric Pollution.—The purity of the atmosphere is a matter of concern to everyone especially those living in industrial districts and crowded city areas. The available facts on the extent, character and variation of atmospheric pollution are contained in the Annual

Reports on observations made by local authorities and other bodies co-operating with the Department of Scientific and Industrial Research in the study of the subject. The 22nd Report just issued (H. M. Stationery Office) records and discusses the results obtained in the year ending 31st March 1936. It also discusses the trend of observations over periods of from ten to twenty years in several districts for which sufficient "long period" results are available.

* * *

Mineral Wealth of Gangapur.—Details of the mineral resources and mining possibilities of one of India's rich mineral areas is given in a report just published from the Geological Survey of India. Special interest was attached to the area as a result of the discovery by Dr. E. Spencer of Messrs. Bird & Co., Calcutta, of a dome-shaped structure exposing manganiferous rocks of the gondite type and crystalline marble. The greater part of the area is situated in the Gangapur State in the Eastern States Agency. The mapped area covers 2,500 square miles and is structurally a highly compressed anticlinorium and exposed rocks mainly belonging to the Archæan group. The memoir also gives a description of the economic mineral deposits of the Gangapur State which is likely to be of use to those interested in the mineral industry of this part of India. The most important deposits are of manganese ore and limestone and dolomite. The reserves of limestone and dolomite in the State run into several hundred million tons. There are also coal deposits which are of inferior grade; the other less important minerals include lead-ore, red-ochre, barytes, kaolin, quartz-sand, various types of clay, and building and road stones.

* * *

Activities of the Industrial Research Bureau.—The *Report* of the Bureau for the year 1936–37 (published by the Manager of Publications, Delhi, 1937) has just been published. The *Report* which is dealt with in five chapters comprises an account of the activities of the organisation which was brought into operation on the 1st April 1935 to develop Indian Industrial Research. The first chapter gives an account of the activities of the Industrial Research Council which is an advisory body consisting of representatives and non-official nominees of the Central, Provincial and leading State governments, in which is vested the duty of co-ordinating and developing Industrial Research. This body which meets once a year at various centres held its second session at Calcutta on the 2nd and 3rd July 1936. The second chapter deals with the work of the Bureau, and also the research work conducted at the Government Test House. The investigations dealt with during the year, cover a very large range and include among others investigations on paints, dry cells, vegetable oils for internal combustion, engines and electric lamps. The work conducted by the Research Bureau on glass has been dealt with in a separate chapter, and refers to the physical and chemical analysis of the raw materials, examination of the possibilities of preparing low-melting-temperature glasses and preparation of liquid gold and of China glass for use in bangle manufacture. The last chapter of the report deals with the work on oils and soaps. A Committee was appointed in the year for surveying the research already conducted and in progress on fatty oils, soaps and essential oils and to advise on the co-ordination of research generally and in particular on the allocation of future research to suitable centres. The Committee suggested that the work should be allocated to various Provincial and State laboratories and recommended to the Imperial Council of Agricultural Research to consider the possibility of encouraging the cultivation of certain essential-oil bearing plants. The Committee also suggested that the Bureau should collate and publish a digest of all available information on Indian vegetable oils. An important Bulletin on vegetable oils, prepared by Mr. N. Brodie, has since been published.

* * *

Daylight Illumination Necessary for Clerical Work.—The standard of daylight illumination, below which clerical workers seek the assistance of artificial light, has been determined by a mechanical method for the first time. The method and the way to use the results obtained are described in Technical Paper No. 19 of the Illumination Research Committee (H. M. Stationery Office, Price 6*d*). The results are of importance to architects and others concerned with the design of clerical offices, particularly as they indicate that some of the minimum standards suggested in the past are much too low.

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Royal Asiatic Society of Bengal.—At the Ordinary Monthly Meeting held on the 5th July, Mr. S. K. Banerji read a paper on "The Quwwat-ul-Islam, the oldest Mosque in Delhi". The mosque representing the architecture of the 12th century is a landmark in Indian History representing the ushering in of a new era in Indian culture and politics.

The following exhibits were shown and commented upon:—(1) SUNITI KUMAR CHATTERJI: *Three Old Brass Utensils with Incised Designs*; (2) CHINTAHARAN CHAKRAVARTI: *The Society's Collection of Manuscripts of Sanskrit Works on the Game of Chess*; (3) M. MAHFUZ-UL-HAQ: *Three Valuable Persian Manuscripts of Jami's*: (1) *Sharh-i-Rubaiyyat*, (ii) *Lawaih, and* (iii) *Lawami, transcribed by Sultan Ali of Mashhad in* 882 *A.H.* (1477–78 *A.D.*).

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Indian Science Congress Association.—Scientists who have accepted the invitation to join the British delegation:—Dr. F. W. Aston, Cavendish Laboratory, Cambridge; Prof. C. B. Fawcett, Professor of Geography, University College, London; H. J. E. Peake, Esq., Vice-President, Royal Anthropological Institute.

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The University of Bombay: *Royal Institute of Science, Bombay.*—The members of the Industrial Research Council of India visited the Institute on the 6th July 1937.

Mr. N. R. Trivedi, B.A. (Cantab.), M.A. (Bom.), has been appointed Lecturer in Mathematics.

Dr. S. H. Lele of the Zoology Department has been transferred to the Elphinstone College in the newly created Science Department as Lecturer in Biology.

* * *

University of Mysore: *Personnel.*—Consequent on the retirement of Dr. E. P. Metcalfe,

the following appointments have been ordered with effect from the commencement of the current session:—(1) Mr. N. S. Subba Rao appointed as Vice-Chancellor and relieved of the charge of the Department of Public Instruction by Mr. E. G. McAlpine, Professor of English and Principal, Central College, appointed Director of Public Instruction. Mr. A. B. Mackintosh, Professor of English, to be Principal, Central College, *vice* Mr. E. G. McAlpine, on his return from leave. Mr. C. R. Narayana Rao, Professor of Zoology, Central College, to act as Principal *vice* Mr. Mackintosh on leave. (2) Dr. J. F. Robinson, B.A., M.D., F.A.C.S., F.R.C.S.E., Principal, Medical College, Mysore, has been granted leave for seven months from the 22nd June 1937 and Mr. D. S. Puttanna, B.A., F.R.C.S.E., L.M., D.T.M., District Medical Officer, Kadur District, appointed to act as Principal, Medical College, during Dr. Robinson's absence on leave. (3) Rao Bahadur Mr. B. Venkatesachar, M.A., F.Inst.P., Professor of Mathematical Physics, Central College, Bangalore, was permitted to retire from service from the 18th June 1937.

* * *

Galvanometer Catalogue.—A complete line of galvanometers and dynamometers is listed by the Leeds and Northrup Company in their catalogue on these instruments which has just been revised. Several newly developed instruments are included in the publication. A narrow-coil galvanometer provides an extremely high voltage-sensitivity combined with a very short period. A Dual galvanometer includes all the advantages of a portable lamp and scale galvanometer, and has a sensitivity fifty times as high. Specifications and listings have been brought up to date throughout the catalogue.

A copy of this publication (Catalogue ED) may be obtained upon request to The Scientific Instrument Co., Ltd., 5A Albert Road, Allahabad, the Agents of the Leeds and Northrup Company, 4934, Stenton Avenue, Philadelphia, Pennsylvania.

* * *

Announcements.

Indian Science Congress Association.—*Discussions.*—The following discussions have been tentatively arranged for the Jubilee Meeting of the Indian Science Congress:—

SECTIONAL DISCUSSIONS.

Section of Chemistry.—(1) Recent Advances in the structure of alkaloids; (2) Chemistry and industrial development in India.

Section of Geology.—(1) Pre-Cambrian sedimentation; (2) The origin of banded gneisses; (3) Plateau basalts; (4) The significance of the 'Main Boundary Faults' of the Himalayas.

Section of Geography and Geodesy.—(1) The teaching of geography in India.

Section of Botany.—(1) The origin and relations of the Himalayan flora; (2) A national herbarium for India (in co-operation with the Indian Botanical Society); (3) Algal problems peculiar to the tropics and especially to India.

Section of Zoology.—(1) Animal ecology in relation to India.

Section of Anthropology.—(1) Blood groupings and racial classification.

Section of Medical Research.—(1) Immunity in protozoal infections; (2) Nutritional disease in India; (3) Black water fever; (4) Cholera.

Section of Physiology.—(1) Physiology of the individual in health and disease; (2) Diet and adaptation to climate; (3) Climate and its influence on the thyroid-adrenal apparatus.

Section of Psychology.—(1) The contributions of abnormal psychology to normal psychology.

JOINT SECTIONAL DISCUSSIONS.

Sections of Mathematics and Physics and Chemistry.—(1) Recent advances in molecular structure from the physico-chemical standpoint.

Sections of Geology and Botany.—(1) Discrepancies in the chronological testimony of plant and animal fossils.

Sections of Botany and Agriculture.—(1) The dissemination of cereal rusts in India; (2) The need for a central station for standard cultures of fungi in India.

Sections of Zoology and Entomology.—(1) The position of Entomology in the Indian Universities.

Sections of Entomology and Agriculture.—(1) Biological control of insect pests.

Sections of Botany, Chemistry and Agriculture.—(1) The absorption of salts by plants.

Sections of Botany, Agriculture, Mathematics and Physics.—(1) The importance of phenological observations in India (in co-operation with the Indian Botanical Society).

Sections of Botany, Zoology and Agriculture.—(1) The structure of the chromosome; (2) The species concept in the light of cytology and genetics.

Sections of Mathematics and Physics, Geology, Geography and Geodesy and Agriculture.—(1) River physics in India (in co-operation with the National Institute of Sciences of India).

Sections of Chemistry, Zoology, Medical Research and Agriculture.—(1) Colloids in Biology, Medicine and Agriculture. It is also hoped to arrange the following discussions:—

Sections of Zoology, Medical Research, Veterinary Research, Entomology, and Agriculture.—(1) The relation of Zoology to Medicine, Veterinary Science and Agriculture.

Members who wish to have summaries of their remarks printed in advance of the Meeting should send the summaries to the Presidents of the Sections concerned not later than the 1st of October 1937.

* * *

Indian Chemical Society:

J. M. Das-Gupta Memorial Medal.—Applications are invited for the above Gold Medal

for 1937 from Research Chemists *of any age*. The award will be made on unpublished researches and/or on independent papers published in the *Journal of the Indian Chemical Society* by the candidates during the years 1936 and 1937. Applications together with four copies of each reprint or typewritten paper should reach the Hon. Secretary *not later than* 30*th September* 1937.

Sir P. C. Ray 70th Birthday Commemoration Medal.—Applications are invited from Research Chemists *below* 30 *years of age* for the above competition. Only independent papers, which have been published in the *Journal of the Indian Chemical Society* during 1936, will be considered.

Applications together with 3 copies of reprints of each paper are to reach the Hon. Secretary not later than 30*th September* 1937.

Further particulars for the above competitions may be obtained from the *Hony. Secretary*, Indian Chemical Society, 92, Upper Circular Road, Calcutta.

* * *

The Indian Population and Family Hygiene Conference.—It is proposed to hold the Second Indian Population Conference and the First Family Hygiene Conference at Bombay in the second week of January (about the 12th), 1938. There will be a combined public session after which the Conference will dissolve into the following sections :—

Population.—(1) Economics ; (2) Sociology & Anthropology ; (3) Nutrition ; (4) Vital Statistics.

Family Hygiene.—(1) Maternity & Child Welfare ; (2) Birth Control & Sterilization ; (3) Medical Problems including Sterility, Abortion and Venereal Diseases ; (4) Problems of Sex including Sex Education & Sexual Perversion ; (5) Housing and Health.

The papers to be read at the Conference and the Presidential Addresses, General and Sectional, will be printed and made available to the delegates and members at the opening of the Conference. The names of the General and Sectional Presidents will be communicated in due course.

Those intending to contribute papers are requested to communicate with the Honorary Secretary, The Indian Population and Family Hygiene Conference, Kodale House, Hornby Road, Bombay 1, *not later than* 1*st November* 1937.

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An Outline of Cytological Technique for Plant Breeders.—In the review of the bulletin which appeared in this *Journal* (1937, **5**, No. 11, 625), the name of the publishers was inadvertently omitted. The bulletin is issued by the Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, at the price of 1*sh.* 6*d.*

* * *

We acknowledge with thanks receipt of the following :—

" The Agricultural Gazette of New South Wales," Vol. 48, No. 6.

" Journal of Agricultural Research," Vol. 54, Nos. 6 and 7.

" Monthly Bulletin of Agricultural Science and Practice, " No. 6, June 1937.

" Journal of Agriculture and Live-Stock in India, " Vol. 6, Part 3, May 1937.

" The Philippine Agriculturist," Vol. 26, No. 1.

" Journal of the Royal Society of Arts," Vol. 85, Nos. 4409–12.

"Journal of the Indian Botanical Society, " Vol. 16, No. 3.

" Communications from the Boyce Thomson Institute," Vol. 8, No. 5.

"Journal of the Institute of Brewing, " Vol. 43, No. 6.

" The Calcutta Review," Vol. 63, No. 3.

" Chemical Age," Vol. 36, Nos. 934–37.

" Journal of Chemical Physics," Vol. 5, No. 6.

" Journal of the Indian Chemical Society, " Vol. 14, Nos. 3 and 4.

" Berichte der Deutschen Chemischen Gesellschaft," Vol. 70, No. 6.

" Journal de Chimie Physique, " Vol. 34, No. 5.

" Journal of Entomology and Zoology, " Vol. 29, No. 1.

" Experiment Station Record," Vol. 76, No. 5.

" Transactions of the Faraday Society, " Vol. 33, Part 6.

" Indian Forrester, " Vol. 63, No. 6.

" Forschungen und Fortschritte, " Vol. 13, No. 17.

" Indian Trade Journal, " Vol. 125, No. 1619.

" Journal of the Indian Mathematical Society, " Vol. 2, No. 6.

" The Calcutta Medical Journal, " Vol. 32, No. 6.

" Medico-Surgical Suggestions, " Vol. 6, No. 6.

" Review of Applied Micology, " Vol. 16, No. 5.

" Journal of the American Museum of Natural History, " Vol. 40, No. 1.

" Nature, " Vol. 139, Nos. 3525–28.

" Journal of Nutrition, " Vol. 13, No. 5.

" Canadian Journal of Research, " Vol. 15, No. 5.

" Journal of Research (National Bureau of Standards, " Vol. 18, Nos. 2 and 3.

" Science and Culture, " Vol. 2, No. 12.

" The Sky, " Vol. I, No. 7.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences :

June 1937.—SECTION A.—R. S. KRISHNAN : *Dispersion of Depolarisation of Light-Scattering in Colloids—Part IV. Iodine, Graphite, Stearic Acid, Vanadium Pentoxide, Arsenic Trisulphide and Ferric Hydroxide Sols.*—From a study of the absorption coefficients and the dispersion of depolarisation, conclusions are drawn regarding size and shape of the colloidal particles. F. C. AULUCK AND S. CHOWLA : *A Property of Numbers.* S. CHOWLA : *On Some Infinite Series Involving Arithmetical Functions.* S. CHOWLA : *On Some Infinite Series Involving Arithmetical Functions (II).* F. C. AULUCK : *A Generalization of the Simson Line.* B. R. SETH : *On the Sufficiency of the Consistency Equations.* B. K. SINGH AND M. R. SUD : *Studies in the Substituted Quaternary Azonium Compounds—Part V. The Molecular State of Phenyldimethylazonium, Phenylmethylethylazonium, Phenyldiethylazonium, Phenylmethylbenzylazonium, Phenylpropylbenzylazonium Iodides in Dilute Solution.*—The molecular state is derived from molecular weight determinations carried out on dilute aqueous and alcoholic solutions by the boiling point method. P. V. KRISHNA IYER : *The Distribution of the Mean of Fisher's* t^2 *for Samples from a Normal Population.*—Suggestions are put forward for determining the significance of the difference between the means of samples of different sizes. H. S. VENKATARAMIAH : *The Magnetic Susceptibility of Copper Amalgam.*—Addition of even small quantities of copper decreases the diamagnetic susceptibility of mercury considerably. G. R. GOGTE : *Chemistry of β-Aryl Glutaconic Acids—Part III. Condensations with Phenolic Ethers.* S. ZAFARUDDIN AHMED AND R. D. DESAI : *Heterocyclic Compounds—Part II. The Synthesis of Cyclopenteno-(1′ : 2′ : 4 : 3)-carbostyril Derivatives.* R. S. KRISHNAN : *Dispersion of Depolarisation of Light-Scattering in Colloids—Part V. Colloidal Dye-Stuffs.*—In the case of dye-stuffs also the depolarisation values attain their maximum value in the region of specific absorption. S. R. SAVUR : *The Use of the Median in Tests of Significance.*—A new test of significances called ∓ test, in which the median is used, is given. The application of this test is quite simple. R. S. KRISHNAN : *Critical Opalescence of Liquid Mixtures.*—Rousset's theory of secondary scattering does not fully explain the finite value of depolarisation of the critical opalescence. The formation of clusters must also be considered. Experimental evidence shows that these clusters exist even at temperatures considerably removed from critical solution temperature. R. PADMANABHAN : *The Fluorescence of Acetone Vapour.*—There are a number of diffuse bands superposed on a continuous spectrum. A similar fine structure is also observed for methyl ethyl ketone.

June 1937. SECTION B.—DONTCHO KOSTOFF : *Chromosome Behaviour in Triticum Hybrids and Allied Genera—I. Interspecific Hybrids with* Triticum Timopheevi.—Cytological study of the hybrids from a number of cross combinations indicates that the chromosomes of A and B genoms of *Tr. Timopheevi* are not homologous with the chromosomes of S genoms of *Secale cereale.* In other words, genoms A and B are not homologous with genom S. DONTCHO KOSTOFF : *Studies on Polyploid Plants—XVI.* Nicotiana rustica × Nicotiana tabacum *Amphidiploid.*—The method of centrifuging germinated seeds has been applied successfully for inducing chromosome doubling in hybrid seedlings in order to produce fertile amphidiploid plants from sterile hybrids of *N. Rustica and N. tabacum.* DONTCHO KOSTOFF : *Studies on Polyploid Plants—XVII.* Nicotiana multivalvis ($2n = 48$) × Nicotiana suaveolens ($2n = 32$) *Amphidiploid* ($2n = 80$.)—Under the influence of high temperature, hybrids between *N. multivalvis* and *N. suaveolens* which are normally self-sterile and form abortive pollen, produce amphidiploid *N. multivalvis* × *N. suaveolens* which sets a large amount of seed. The amphidiploids were more robust than F_1-hybrids and the flowers were slightly larger. R. GOPALA AIYAR AND N. KESAVA PANIKKAR : *Observations on the Swarming Habits and Lunar Periodicity of* Platynereis *sp. from the Madras Harbour.*—The Heteronereids are described. S. JONES : *Observations on the Breeding Habits and Development of Certain Brackish Water Fishes of Adyar, Madras.*—The breeding habits and development of *Acentrogobius viridipunctatus, Petroscirtes bhattacharyæ* and *Boleophthalmus boddærti* are made known for the first time. B. RAMA RAO AND L. RAMA RAO : *On "Bidalotite", a New Orthorhombic Pyroxene derived from Cordierite.*—A new type of orthorhombic pyroxene which is distinct from the known members of the enstatite hypersthene series which must therefore be recognised as a new mineral, has been described. M. S. RANDHAWA: *Genus* Zygnemopsis *in Northern India.* R. D. VIDYARTHI : *New Avian Trematodes of the Sub-Subfamily* Cotylurini *Dubois* 1936, (*Family* Strigeidæ, *Raillet* 1919.—*Apatemon indicus* n. sp., *Apatemon casarcus* n. sp., *Pseudostrigea sarcogypo-nis* n. sp., and *Cotylurus orientalis* sp. nov., have been described. HUKAM CHAND : *Study of the Fungus Flora of the Lahore Soils.*—About 20 speices of fungi have been recorded of which some are new.

Indian Chemical Society:

March 1937.—TEJENDRA NATH GHOSH : *Quinoline Derivatives—Part II.* NRIPENDRA NATH CHATTERJEE : *Spiro-Compounds—Part III. Synthesis of* Cyclo-*Hexane-spiro*-cyclo*butane Derivatives by the Application of the Dieckmann Reaction to Esters of the Tricarballylic Series.* SUBODH GOBINDA CHAUDHURY AND JYOTIRMOY SEN-GUPTA : *On the Nature of the Electric Charge of a Precipitate formed in Presence of an Excess of either of its Constituent Ions—Part I.* RAM NATH MISRA AND SIKHIBHUSHAN DUTT : *Chemical Examination of the Seeds of* Cichorium intybus *Linn. Constituents of the Oil from the Seeds.* B. B. DEY AND (MISS) P. LAKSHMI KANTAM : *Studies in the Colarnine Series—Part IX. Attempts to Synthesise Alkaloids of the Cryptopine Types.* ATMA RAM AND N. R. DHAR : *Photopolymerisation of Formaldehyde to Reducing Sugars* in vitro. PHULDEO

SAHAY VARMA AND M. KRISHNAMURTI : *Halogenation—Part XVII. Bromination and Iodination of Diphenyl.* PHULDEO SAHAY VARMA, VISHWANATH SAHAY AND B. RAM SUBRAMONIUM : *Halogenation—Part XVIII. Halogenation of Ethylbenzene.* K. S. GURURAJA DOSS : *Interpretation of Adhesion Tension Data.* SHRIDHAR SARVOTTAM JOSHI AND K. RAMA DAS : *Studies in the Coagulation of Colloids—Part XVII. The Anomalous Coagulative Power of Aqueous Mercury Chloride.* K. MADHUSUDANAN PANDALAI : *A Note on the Constitution of Formic Acid.*

April 1937.—MATA PRASAD, JAGDISH SHANKAR AND B. H. PEERMOHAMED : *An X-Ray Investigation of the Crystals of Diphenylene Disulphide (Thianthrene) and Diphenyl Disulphide.* HARENDRA KUMAR ACHARYA : *Properties of Activated Sugar Charcoal Coated with Various Organic Substances—Part II. Adsorption of Acids.* SUSIL KUMAR RAY AND DURGADAS MAJUMDAR : *On the Study of Polyhalides—Part V. The Structure of Polyhalides.* M. GOSWAMI AND A. SHAHA : *Analytical Uses of Nessler's Reagent—Part III. Estimation of Formaldehyde, Pyrogallol, Tannic and Gallic Acids, their Absolute Oxygen Values.* DINES CHANDRA SEN : *Studies in the Camphor Series—Part IV. Synthesis of Thiofenchone and Two Isomeric Bis-thiocamphors and their Derivatives.* NIRMALANANDA PALIT : *A Modification of the Gaureschi Pyridine Synthesis—Part I.* PROMODE BEHARI BHATTACHARYYA : *On the Physico-Chemical Properties of Electrodialysed Gels of Silica, Alumina, Ferric Hydroxide and their Mixtures. Cataphoretic Velocity and P_H—Part III.* HIRENDRA NATH DAS-GUPTA : *Studies in Organo-arsenic Compounds—Part IV. Heterocyclic Ring containing Arsenic.* KEDAR NATH GAIND, ABDUL WAHAB KHAN AND JNANENDRA NATH RAY : *Synthesis of New Local Anæsthetics—Part II.* SISIR KUMAR GUHA : *Indigoid Vat Dyes of the Isatin Series—Part II. 3-Indole-2'-(6'-methyl)-thionaphtheneindigos.*

Society of Biological Chemists (India):

June 26, 1937.—M. T. CHOBE AND B. SANJIVA RAO : *Essential Oil from* Atlantic monophylla, *Wild Lime.* K. V. GIRI : *Stabilization of Vitamin C by Pyrophosphate.* A. KRISHNAMURTHI : *The Non-Protein Nitrogen of Malt Extracts.* C. N. ACHARYA : *Comparison of Methods for the Estimation of Furfurols in Soils and Plant Materials.* S. D. ACHAR : *Some Aspects of Disease Control in Animals.*

Indian Botanical Society:

June 1937.—S. R. BOSE : *Cytology Study of Basidia of Polyporacear* (Presidential Address at the 16th Annual Meeting of the Indian Botanical Society at Hyderabad, January 1937). B. N. SINGH AND B. N. LAL : *Investigation of the Physiological and Chemical Changes accompanying Viviparous Germination in Mango.* R. H. RICHHARIA : *Investigation on F_1 and F_2 Hybrids between* Brassica carinata *and* Raphanus sativus. T. S. MAHABALE : *On the Discovery of the Prothallus of* Lycopodium *in India (Preliminary Note).* ASOKA KUMAR PAUL : *Development of Ovule and Embryo-sac of* Tamarindus indica *Linn.* I. BANERJI : *Sterility in* Colocasia antiquorum *Schott.* G. TISCHLER : *On Some Problems of Cytotaxonomy and Cytœcology.* R. E. COOPER : *On the Variability of the Floral Parts of* Rondeletia odorata *Jacq.*

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